USER'S MANUAL 990-295
Revision B June 2007

100DP/300DP DUAL PULSE STORED ENERGY RESISTANCE WELDING POWER SUPPLIES

Model	Stock No.
100DP/115	1-293-01
100DP/230	1-293-01-01
300DP/115	1-294-01
300DP/230	1-294-01-01

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Printed in the United States of America.

Revision Record

Revision	EO	Date	Basis of Revision
A	20633	12/05	None. Original edition.
B	21448	6/07	Added open load detection feature

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CONTACT US

Thank you for purchasing a Miyachi Unitek™ Resistance Welding System Control.

Upon receipt of your equipment, please thoroughly inspect it for shipping damage prior to its installation. Should there be any damage, please immediately contact the shipping company to file a claim, and notify Miyachi Unitek at:

1820 South Myrtle Avenue
P.O. Box 5033
Monrovia, CA 91017-7133

Telephone: **(626) 303-5676**

FAX: **(626) 358-8048**

e-mail: **info@unitekmiyachi.com**

The purpose of this manual is to supply operating and maintenance personnel with the information needed to properly and safely operate and maintain the Miyachi Unitek™ 100DP and 300DP Resistance Welding System Control.

We have made every effort to ensure that the information in this manual is accurate and adequate.

If you have any questions, or if you have suggestions to improve this manual, please contact us at the above location/numbers.

Miyachi Unitek Corporation is not responsible for any loss due to improper use of this product.

SAFETY NOTES

DANGER

- ***Lethal voltages exist within this unit***. ***Never*** perform any maintenance inside this unit.
- ***Never*** perform any welding operation without wearing protective safety glasses.

This instruction manual describes how to operate, maintain and service the 100DP and 300DP Resistance Welding Power Supplies, and provides instructions relating to its ***safe*** use. A separate manual provides similar information for the weld head used in conjunction with the power supply. Procedures described in these manuals ***must*** be performed, as detailed, by ***qualified*** and ***trained*** personnel.

For ***safety***, and to effectively take advantage of the full capabilities of the weld head and power supply, please read these instruction manuals before attempting to use them.

Procedures other than those described in these manuals or not performed as prescribed in them, may expose personnel to electrical or burn hazards.

After reading these manuals, retain them for future reference when any questions arise regarding the proper and ***safe*** operation of the power supply.

Please note the following conventions used in this manual:

WARNING: Comments marked this way warn the reader of conditions which might result in immediate death or serious injury.

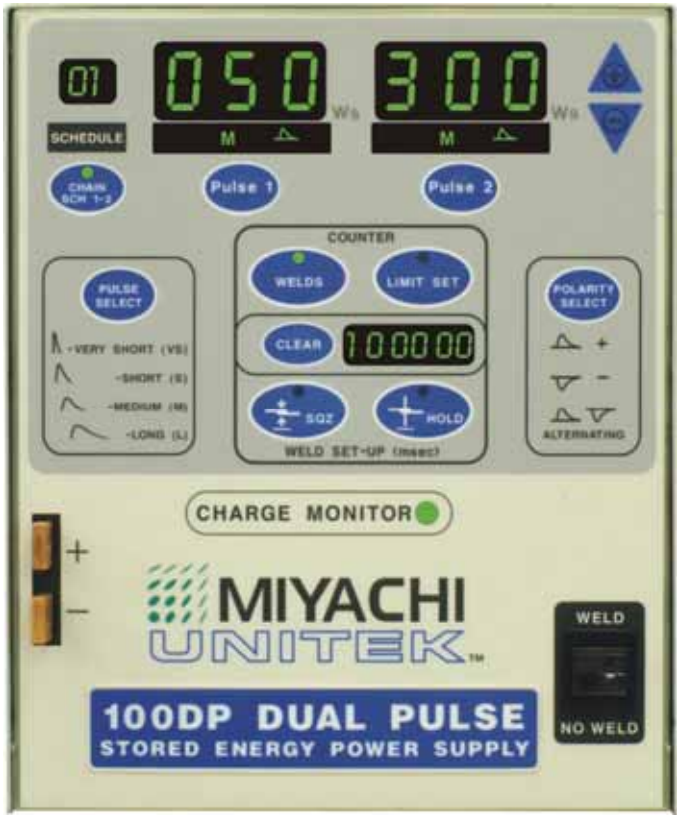
CAUTION: Comments marked this way warn the reader of conditions which might result in either damage to the equipment, or injury to the individual.

CHAPTER 1
Description

Section I: Features

Features

The Miyachi Unitek **100DP/300DP Dual Pulse Resistance Welding Power Supply** precisely controls welding energy and weld head timing.



- Multi-function microprocessor control provides repeatable process control and is compatible with air or manually actuated weld heads. Facilitates multiple applications at a single work-station and protects weld schedules from changes by unauthorized personnel.
- Dual pulse welding eliminates weld splash. Improves weld quality, especially when welding plated materials.
- Alternating polarity allows the user to set up a pulse to change from positive to negative polarity each time the welder is fired. This allows the user to equalize the wear between two electrodes in many parallel gap welding processes.
- Two air valve drivers are provided to sequentially control two separate air operated weld heads, if desired. As shipped, Air Valve Driver 1 is configured to drive a 24 VAC weld head, but can be reconfigured to drive a 24VDC weld head instead. Air Valve Driver 2 can only drive a 24VDC weld head.
- Three relays provide signals for when the unit is ready to weld, when a weld is completed, and when the weld counter has reached its preset limit.
- Remote schedule selection simplifies use in automated systems. A **CONTROL SIGNALS** connector accepts remote control signals for Emergency Stop, Remote Weld Inhibit, and Remote Weld Schedule Selection.
- The chain schedule feature allows Schedule 1 and Schedule 2 to be chained together.
- Schedule protection and system security features protects weld schedules from changes by unauthorized personnel.

- The schedule lock feature allows you to restrict welding to one selected weld schedule.
- The digital display allows operators to set welding energy accurately and quickly.
- The Power Supply is compatible with manually actuated weld heads and air actuated heads with 1-level or 2-level foot switches.
- The Power Supply is compatible with force fired and non-force fired weld heads. Squeeze (delay) time is adjustable from 0 to 2.999 seconds.
- A built-in weld counter allows you to control events which are a function of the number of welds made.
- The firing circuit uses single pole, double pole or optical firing (pressure) switches.
- The energy monitor and lockout helps prevent poor welds caused by firing the power supply before the capacitor bank is properly charged or discharged.
- The line failure turndown safety feature discharges the capacitor bank when input power is interrupted.
- The Power Supply is protected from radio frequency interference and electromagnetic interference, resulting in reliable operation even in high electrical noise environments. Input switch debounce circuitry eliminates false triggering.

Detailed instructions on using these features are located in *Chapter 3, Operating Instructions.*

NOTE: For the rest of this manual, the **Miyachi Unitek 100DP/300DP Dual Pulse Resistance Welding Power Supply** will simply be referred to as ***the Power Supply***.

Description

The Power Supplies are versatile, 100 Watt-second and 300 Watt-second stored energy, capacitor discharge, dual pulse power supplies which can effectively solve most precision, small parts, resistance welding problems.

You can program up to 15 weld schedules and save them in memory. A built-in schedule protection feature protects weld schedules from unauthorized or inadvertent changes. The exclusive charge monitor and firing lockout feature guarantees that weld quality is independent of line voltage fluctuations and the speed at which the power supply is operated.

Dual pulse welding improves weld quality and eliminates weld splash. *Dual pulse* means each weld is performed with two pulses with independent energy levels and independent polarity. The first pulse displaces the plating or contamination and reforms the surface so that it is in intimate contact with the electrode. The second pulse welds the base metals.

The remote schedule feature allows the Power Supplies to reliably select weld schedules in automated applications.

The Power Supplies can be used with manual, user actuated, or air actuated weld heads. The units are designed to operate at either 100-120VAC or 200-240VAC, 50/60 Hz.

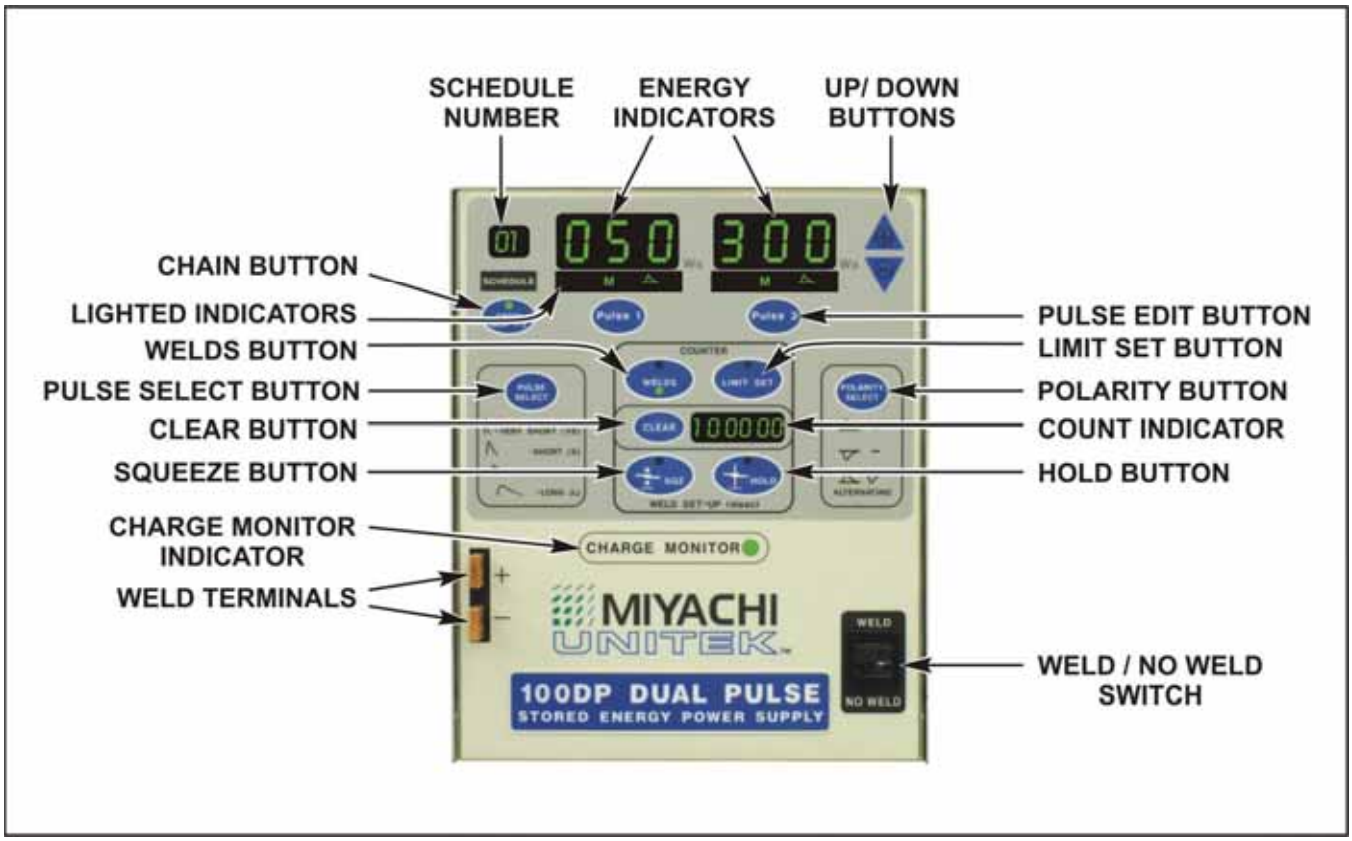
Section II: Major Components

Major Components

The major components are the front panel, which contains the operator's controls and indicators, and the rear panel, which contains fuses, circuit breakers and power and signal connectors. The rear panel connections are discussed in *Chapter 2, Installation and Setup*.

Front Panel Display and Display Controls

The front panel of the Control below shows controls and indicators. The function of each item is described on the following pages.



Front Panel Controls

Schedule Number and Chain Switch

The 2-digit LED displays which welding schedule is selected for use.

The **CHAIN SCH 1-2** button will "chain" Schedule 1 and Schedule 2 together, meaning welding pulses will alternate between these two schedules. The green light on this switch will be ON when the "chain" function is in use.

Welding will continue repeating between these schedules until you press the **CHAIN SCH 1-2** button again and the green light on the button goes OFF. Welding will then continue from a single schedule.

Energy and Pulse Indicators • Pulse Edit Buttons • UP/DOWN Buttons

The 3-digit LED displays the energy for each pulse in Watt-seconds (**Ws**).

When in the "edit" mode, this display will flash until editing is complete.

PULSE and **POLARITY** indicators. These displays will light up to indicate which pulse length and polarity has been selected for each pulse.

Press either of these buttons for approximately 1 second to put the Power Supply into the "edit" mode. This enables you to modify the settings for each weld schedule.

Press the **Pulse 1** button and wait for the LED to flash. When the LED flashes, you can change the energy, pulse length, and polarity for Pulse 1. To accept the changes, press the **Pulse 1** button again and the LED will stop flashing. To exit the "editing" mode ***without*** accepting changes, ***press the clear button or any other button*** on the front panel.

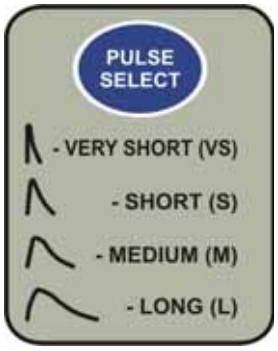
Press the **Pulse 2** button and follow the same procedures to modify Pulse 2.

The UP (**+**) and DOWN (**−**) buttons have two functions.

During "normal" operation, these are used to scroll up or down through the schedule numbers in order to select a schedule. The schedule number displayed in the 2-digit LED is the schedule selected for welding.

In the "editing" mode, these buttons will increase or decrease the values in the **PULSE 1** and **PULSE 2** energy, **WELDS** or **LIMIT SET** displays.

Pulse Select



This button is ***only*** active when the Power Supply is in the "editing" mode. Press this button repeatedly until the pulse duration you want is lit underneath the 3-digit energy display. As shown below, the **MEDIUM (M)** pulse duration is selected.

NOTE: The **VERY SHORT (VS)** setting gives the highest peak current and shortest duration for the energy setting. The **LONG (L)** setting gives the lowest peak current and longest duration for the energy setting.

Weld Counter and Setup

Pressing this button causes the green LED on the button to go ON and the 6-digit **COUNTER** display will show the total number of welds the Power Supply has made since the last time it was reset to zero. This feature can be used to count the number of welds during a particular shift or work day

Pressing this button causes the green LED on the button to go ON and the 6-digit **COUNTER** display will show the **LIMIT SET** for the number of welds made. After the limit is reached, the Power Supply will "beep" each time a weld is made. This signals the Operator to take action.

Pressing this button for about 1 second causes the green LED on the button to go ON and the 6-digit **COUNTER** display to blink. This allows the ▲▼ arrows to increase or decrease the **LIMIT SET** value. Pressing this button again saves the setting and stops the 6 digit display from blinking and saves the value.

This feature is useful for counting weld made on a set of electrodes to determine when to change electrodes. .

When you are using the **weld count**, **limit set**, **squeeze time**, or **hold time** functions, the time in the 6-digit **COUNTER** display will reset to **zero** when you press and hold this button for about a second.

Depending on which button is pressed, this 6-digit display in the **COUNTER** section is used to display the number of welds made (**WELDS**), the limit that has been set for a set of electrodes (**LIMIT SET**), squeeze time (**SQZ**), or the hold time (**HOLD**). It also displays error codes as described in Chapter 4.

Pressing this button causes the green LED on the button to go ON and the 6-digit **COUNTER** display will show the **squeeze time** for the current schedule. Pressing this button for about 1 second causes the green LED on the button to go ON and the 6-digit **COUNTER** display to blink. This allows the ▲▼ arrows to increase or decrease the **squeeze** time. Pressing this button again saves the setting

Pressing this button causes the green LED on the button to go ON and the 6-digit **COUNTER** display will show the **hold time** for the current schedule.
Pressing this button for about 1 second causes the green LED on the button to go ON and the 6-digit **COUNTER** display to blink. This allows the ▲▼ arrows to increase or decrease the **hold** time. Pressing this button again saves the setting.

Polarity Select

This button is ***only*** active when the Power Supply is in the "editing" mode. Press this button repeatedly until the polarity you want is lit underneath the 3-digit energy display. As shown below, positive (**+**) polarity is selected.

NOTE: When **ALTERNATING** polarity is selected, ***both*** waveforms below will be lit.

Charge Monitor

When the green light is lit, the capacitors are fully-charged and ready to weld. The light will turn on a short time after a weld is completed. If the **WELD/NO WELD** switch is in the OFF position, the **CHARGE MONITOR** light will not be lit.

WELD/NO WELD Switch

When the switch is in the **WELD** position, the programmed weld sequence can initiate weld energy.

When you set this switch to the **NO WELD** position, ***no*** weld current can flow. However, the Control ***can*** execute a complete weld sequence. This function is used to adjust the weld head prior to operation.

Emergency Stop Switch Operation

If your work station is equipped with an **EMERGENCY STOP SWITCH** (connected to the emergency stop connection of the Control), operate the switch to immediately stop the welding process. All power to the air valves and power circuits will be disconnected. The 6-digit display will show **E-STOP**. To resume operation, reset the **EMERGENCY STOP SWITCH** to the normal position.

CHAPTER 2
Installation and Setup

Section I: Installation

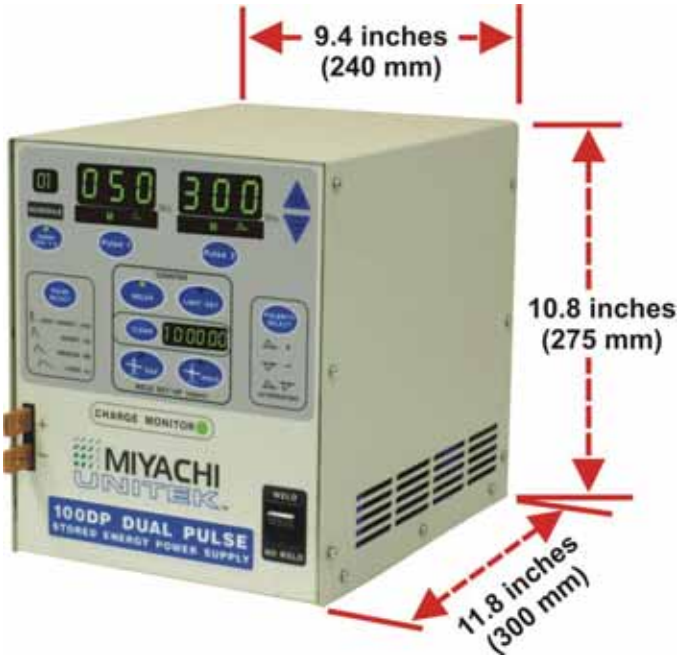
Unpacking

The Power Supply is shipped to you completely assembled, together with the accessories you ordered, and a shipping kit. The contents of the shipping kit is listed in *Appendix A, Technical Specifications*. Be sure that the contents of the shipping kit match the Shipping Kit List and that you have received the accessories that you ordered.

Verify that the Power Supply shows no signs of damage. If it does, please contact the carrier. Also, contact Miyachi Unitek Customer Service at the address, phone number, or e-mail address listed under **Contact Us** in the front of this manual.

Space Requirements

- Allow ample workspace around the Power Supply so that it will not be jostled or struck while welding.
- Allow sufficient clearance around both sides and back of the Power Supply for power and signal cabling runs.
- Install the Power Supply in a well-ventilated area that is free from excessive dust, acids, corrosive gases, salt and moisture.
- Other installation considerations are:
  - The work surface must be level, stable, free from vibration, and capable of supporting the combined weight of the total welding system. The weight of the Power Supply is 66 lbs (30 kg).
  - The Power Supply must be far enough from the weld head to avoid contact with weld splash.
  - Make sure there are ***no*** sources of high-frequency energy close by.



Utilities

Power

Because of the different electrical requirements for the countries in which the Power Supply is used, the Power Supply is shipped without a power cable connector. The required connections for your power cable connector are described in *Appendix B, Electrical and Data Connections.* Input power requirements for the Power Supply are as listed below.

Power Input Specifications

Model	Input Voltage, 50-60 Hz, 3 phase (Vrms)	Ckt Brkr Current (A rms)	Copper Wire Gauge, 7 strands (AWG)	Wire Dia (mm)
100DP/115	100-120	15	10	2.5
100DP/230	200-240	10	10	2.5
300DP/115	100-120	15	10	2.5
300DP/230	200-240	10	10	2.5

Compressed Air and Cooling Water

If you require compressed air and cooling water service for the weld head, please refer to the weld head manufacturer's user's manual for service specifications.

Input Logic Configuration

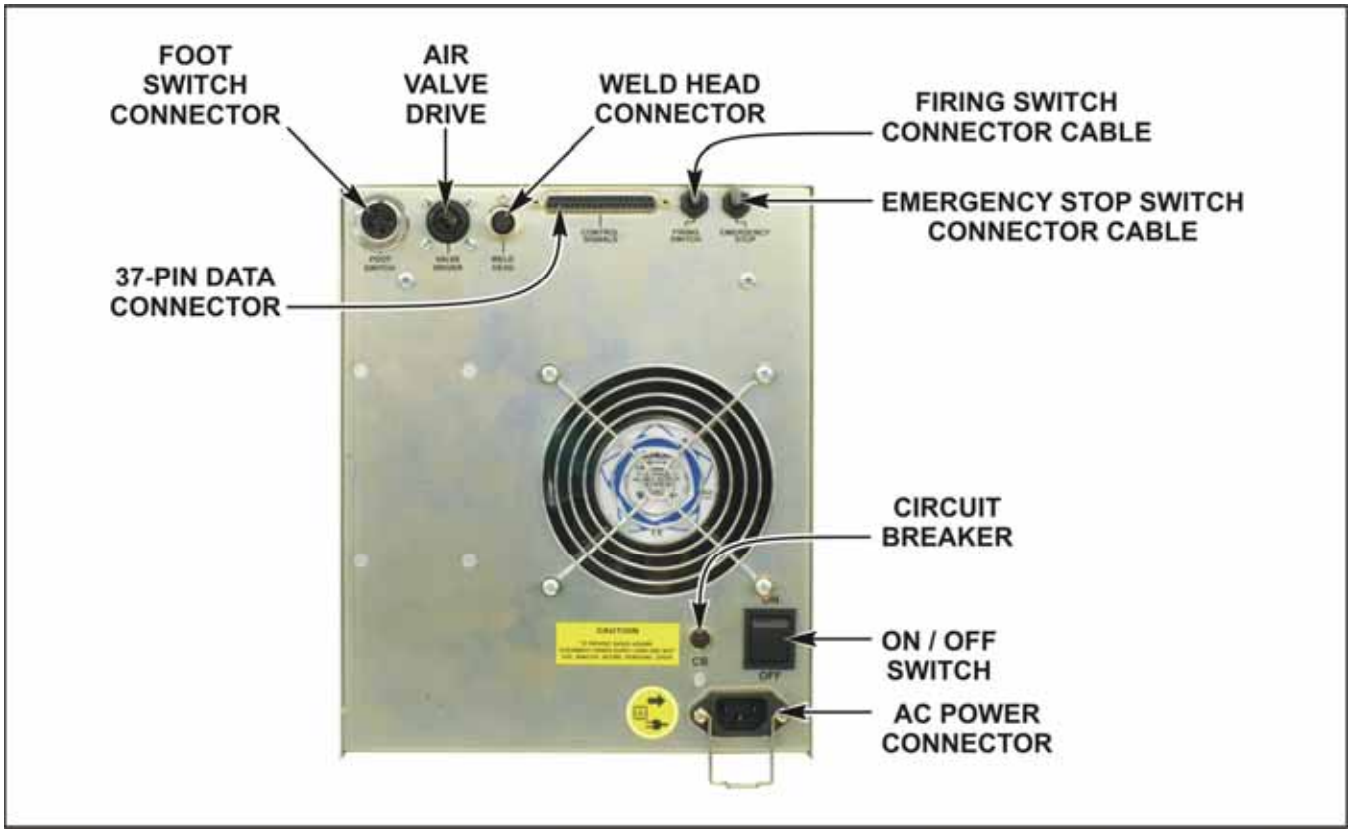
The unit is shipped from the factory configured for **LOW = TRUE INPUTS**. This is used for a switch closure to ground to activate, or to turn an input ON. The unit can also be configured for **HIGH = TRUE INPUTS** which is commonly used for a PLC or other external device to supply +24VDC to activate, or to turn an input ON.

Instructions for changing this configuration, including electrical schematics, are in *Appendix B*.

Section II: Setup

Connections to External Equipment

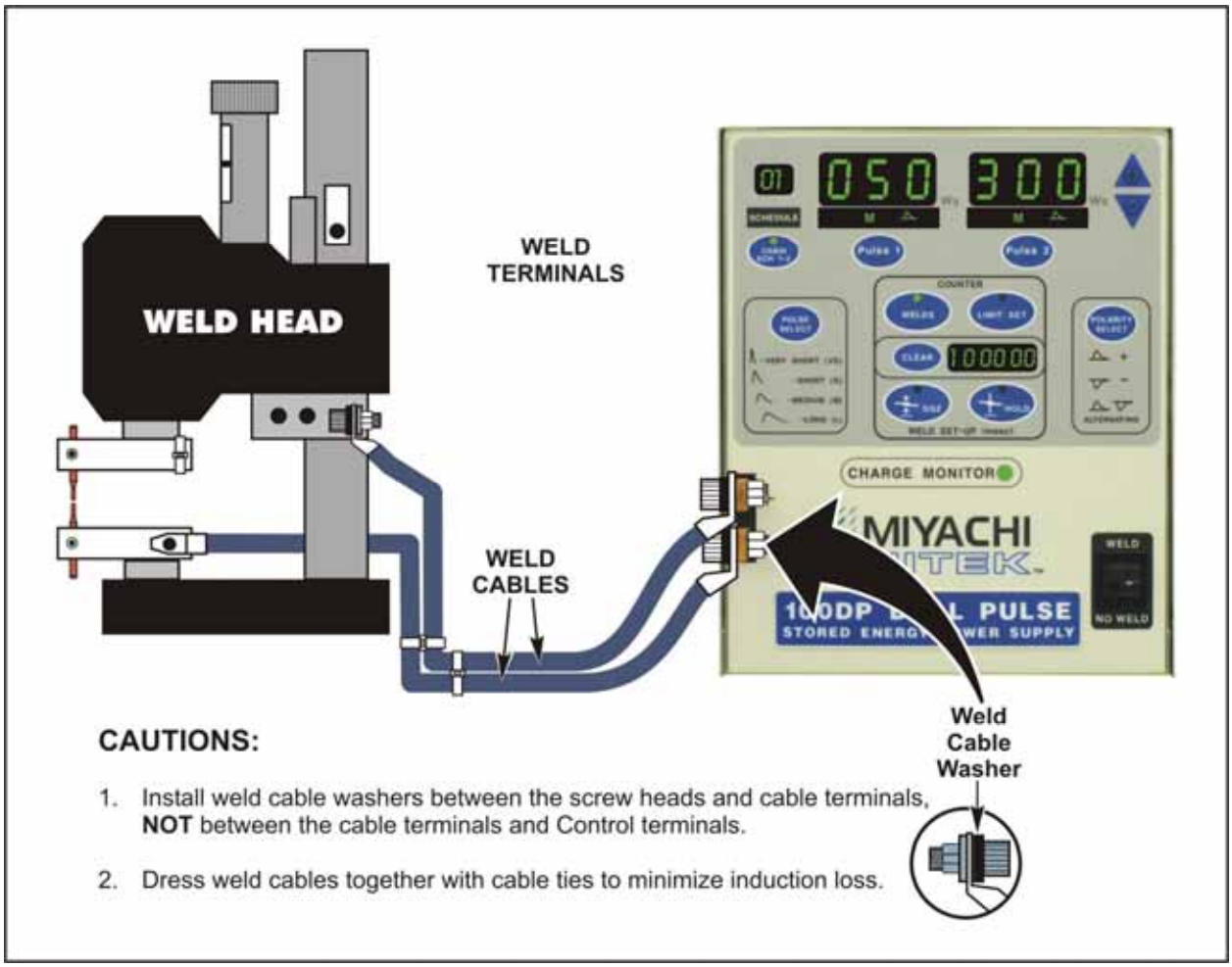
All connections, other than the weld cable connections, between the Power Supply and external equipment are made through the rear panel.



Rear Panel Components and Connectors

NOTE: The weld cable connections from the weld head are made at the weld cable terminals on the front panel.

Weld Head Connections

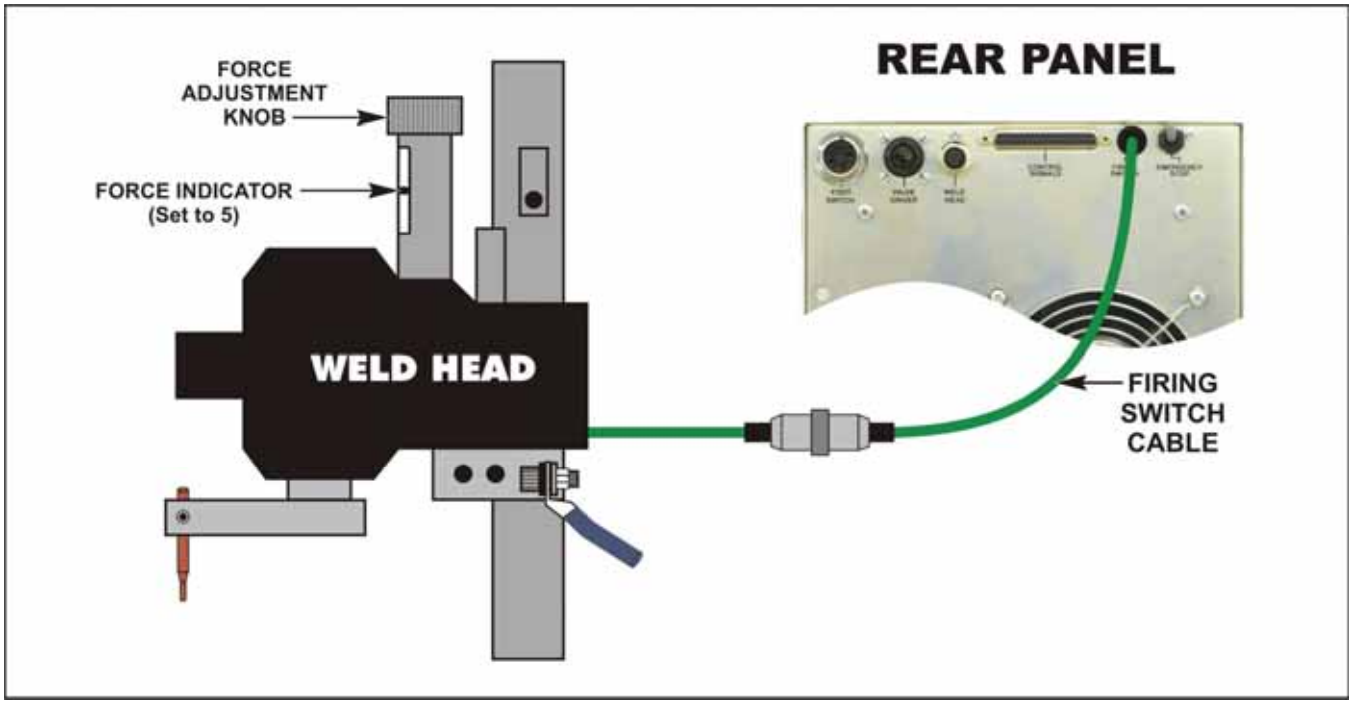

WELD HEAD
WELD TERMINALS
WELD CABLES
CHARGE MONITOR
MIYACHI
CAUTIONS:
1. Install weld cable washers between the screw heads and cable terminals, NOT between the cable terminals and Control terminals.
2. Dress weld cables together with cable ties to minimize induction loss.
Weld Cable Washer

1. Connect one end of a weld cable to the negative (**-**) welding transformer terminal on the Power Supply.
2. Connect one end of the second weld cable to the positive (**+**) welding transformer terminal on the Power Supply.
3. Connect the other end of the weld cables to the weld head.
4. Install electrodes in the weld head electrode holders.

NOTES:

- Do ***not*** attach the firing switch, foot switch or **EMERGENCY STOP** cables at this time.
- If you need additional information about the weld heads, please refer to their user's manuals.

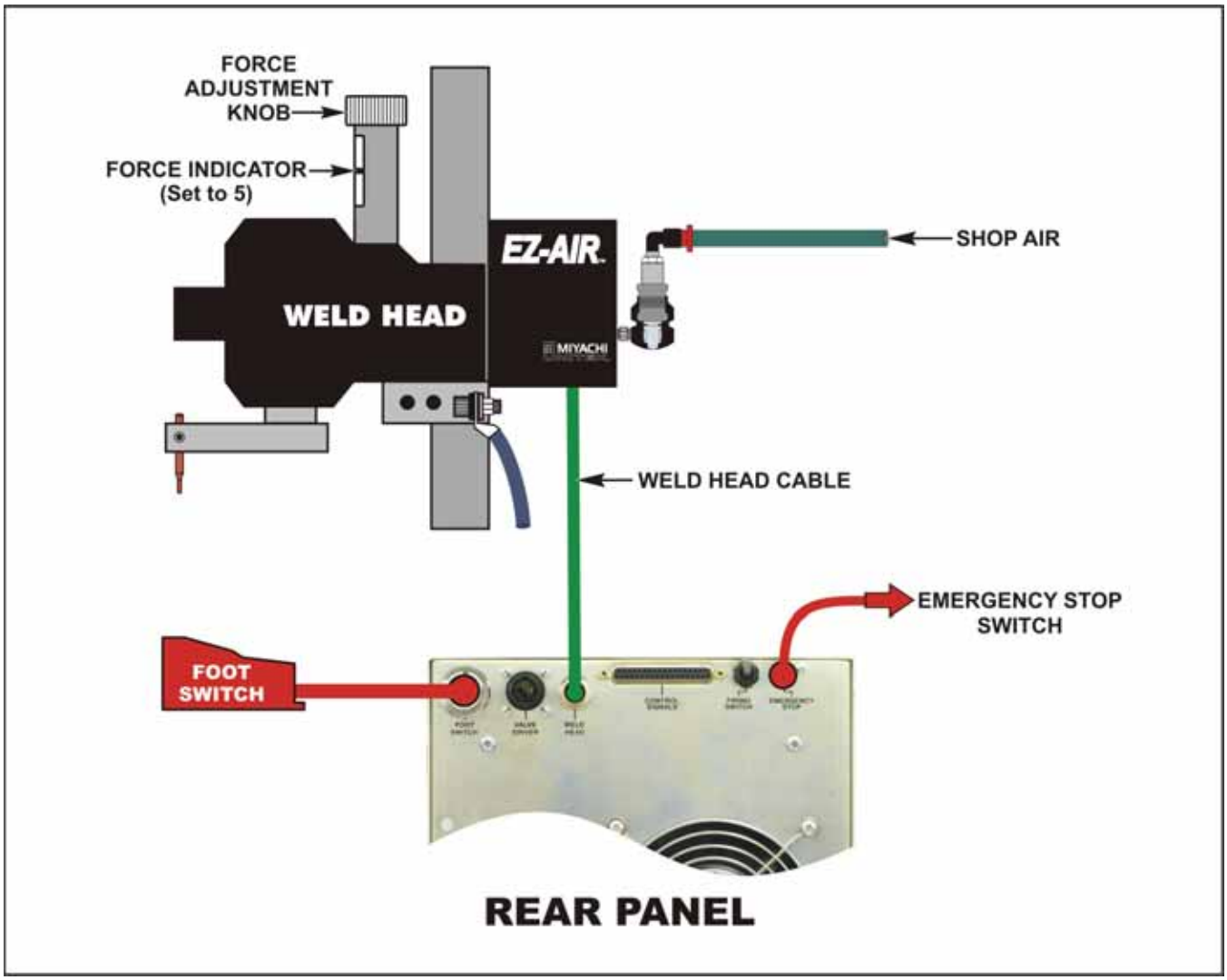
Foot Pedal-Actuated Weld Head Connection



1. Adjust the weld head force adjustment knob to produce **5** units of force, as displayed on the force indicator index.
2. Connect the weld head firing switch cable connector to the Power Supply firing switch cable connector.
3. Connect a normally closed, approved, **EMERGENCY STOP SWITCH** across the two leads of the operator emergency stop switch cable. This switch, when operated (open), will immediately stop the weld cycle. See *Appendix B. Electrical and Data Connections* for circuit details.
4. Set the **WELD/NO WELD** switch on the Power Supply front panel to the **NO WELD** position. In this position, the Power Supply cannot deliver weld energy, but the firing switch connection can be verified.
5. Set the circuit breaker on the rear panel of the Power Supply to the ON position.

EZ-AIR Weld Head Connections

NOTE: These instructions describe connection to the Miyachi Unitek ***EZ-AIR*** weld head. Non-*EZ-AIR* heads may be connected to the Power Supply but are not covered in these instructions. For non-*EZ-AIR* head instructions, refer to the manual provided with the specific weld head.



1. Adjust the weld head force adjustment knob to produce **5** units of force, as displayed on the force indicator index.
2. Connect the weld head firing switch cable connector to the Power Supply firing switch cable connector.

3. Connect a normally closed, approved, **EMERGENCY STOP SWITCH** across the two leads of the operator emergency stop switch cable. This switch, when operated (open), will immediately stop the weld cycle and retract the weld head. See *Appendix B. Electrical and Data Connections* for circuit details.
4. Connect a Model FS2L or FS1L Foot Switch to the Power Supply **FOOT SWITCH** connector.
5. Refer to the weld head manufacturer user's manual. Connect the weld head air valve solenoid cable connector to the Power Supply **AIR VALVE DRIVER** connector.
6. Connect a properly filtered air line to the air inlet fitting on the weld head. Use 0.25 inch O.D. by 0.17 inch I.D. plastic hose with a rated burst pressure of 250 psi. Limit the length of the air line to less than 40 in. (1 m) or electrode motion will be very slow.

   NOTE: Use a lubricator ***only*** with automated installations.
7. Turn on the air system and check for leaks.
8. Set the **WELD/NO WELD** switch on the Power Supply front panel to the **NO WELD** position. In this position, the Power Supply cannot deliver weld energy, but it can Power Supply the weld head.
9. Set the circuit breaker on the rear panel of the Power Supply to the ON position.
10. Press the foot switch to actuate the first level. The weld head upper electrode should descend smoothly to the DOWN position. When it reaches the down position, release the foot switch and proceed to Step 12. If it does ***not*** descend smoothly, proceed to Step 11.
11. Adjust the weld head down speed knob and repeat Step 10 until the upper electrode descends smoothly.
12. Press the foot switch all the way down to close both levels. The weld head upper electrode should descend smoothly to the DOWN position, and send the firing switch signal back to the Power Supply when the preset electrode force is reached. The upper electrode should then ascend smoothly back to the UP position.

CHAPTER 3
Operating Instructions

Section I: Introduction

Before You Start

Before operating the Control, you must be familiar with the following:

- The **location** and **function** of Controls and Indicators. For more information, see *Chapter 1* of this manual.
- The principles of resistance welding and the use of programmed weld schedules. For more information, see *AppendixD, The Basics of Resistance Welding.* For additional information on the welding process, see *AppendixE, Quality Resistance Welding Solutions, Defining the Optimum Process*.

Pre-Operational Checks

Always perform these checks ***before*** attempting to operate the Control.

Connections

Verify that the Control has been connected to a manual or air-actuated weld head as described in *Chapter 2* of this manual. Verify that the **EMERGENCY STOP SWITCH** is connected properly.

Power

Verify that power is connected as described in *Chapter 2* of this manual.

Compressed Air

If you are using an air-actuated weld head, verify that compressed air is connected as described in the appropriate sections of your weld head manual. Turn the compressed air ON**,** and adjust it according to the instructions in your weld head manual.

Adjust Buzzer Loudness

NOTE: This can ***only*** be done when the Power Supply is being powered-up.

1. Press the **POLARITY SELECT** button followed by the **PULSE SELECT** button and wait for the counter display to show **BUZZ**.
2. Use the ▲▼ arrows to adjust the buzzer loudness from 0 to 4.
3. When you get the loudness you like, press **PULSE SELECT** on the front panel to accept the change and return to normal operation.

Initial Setup

1. Set the **WELD/NO WELD** switch on the Control front panel to the **NO WELD** position. In this position, the Control will operate the weld head ***without*** producing weld energy.
2. Adjust the weld head force adjustment knob for a force appropriate for your welding application. A good starting point is the mid-point in the range of the weld head force.
3. When you are ready to perform a weld, be sure to set the **WELD/NO WELD** switch back to the **WELD** position.

Section II. Operation

Using Existing Weld Schedules

1. Use the ▲▼ arrows to select the weld schedule you want to use.
2. Press the **WELD/NO WELD** switch to the **WELD** position.
3. Begin welding using your normal procedures.

   NOTE: Welding will be performed using the values for the schedule you selected until you select a new schedule.

Modify Weld Schedules

1. Press the **WELD/NO WELD** switch to the **NO WELD** position.
2. Use the ▲▼ arrows to select the weld schedule you want to modify.
3. Press the **PULSE 1** button to modify Pulse 1. Hold the button for about 1 second and wait for the LED to turn OFF. Stop pressing the button. The LED will then flash. When the LED is flashing, the Power Supply is in the "edit" mode.
4. To modify the **energy**, press the ▲ arrow to increase energy or press the ▼ arrow to decrease energy.
5. To modify **pulse duration**, press the **PULSE SELECT** button until the pulse length you want is lit underneath the 3-digit energy display.

   NOTE: The **Very short** setting gives the highest peak current and shortest duration for the energy setting. The **Long** setting gives the lowest peak current and longest duration for the energy setting.
6. To modify **polarity**, press the **POLARITY SELECT** button repeatedly until the polarity you want is lit underneath the 3-digit energy display.

   NOTE: When **ALTERNATING** polarity is selected, ***both*** waveforms will be lit.
7. Press the PULSE 1 button to save any changes made.
8. To modify the **squeeze time**, press and hold the **SQZ** button for about 1 second. The green LED on the button goes ON and the 6-digit **COUNTER** display begins to flash.
9. While the 6-digit display is flashing, press the ▲ arrow to increase squeeze time or press the ▼ arrow to decrease the squeeze time.
10. When you get the squeeze time you want, press the **SQZ** button again until the 6-digit **COUNTER** display stops flashing.
11. To modify the **hold time**, press and hold the **HOLD** button for about 1 second. The green LED on the button goes ON and the 6-digit **COUNTER** display begins to flash.

12. While the 6-digit display is flashing, press the ▲ arrow to increase hold time or press the ▼ arrow to decrease the hold time.
13. When you get the hold time you want, press the **HOLD** button again until the 6-digit **COUNTER** display stops flashing.
14. To modify the settings for Pulse 2, press the **Pulse 2** button. Hold the button for about 1 second and wait for the LED to turn OFF. Stop pressing the button. The LED will then flash. When the LED is flashing, the Power Supply is in the "edit" mode.
15. Repeat steps 4 through 6 to program the settings for Pulse 2.
16. To accept the changes, press the **Pulse 2** button again and the LED will stop flashing. To exit the "editing" mode ***without*** accepting changes, ***press clear or any other button*** on the front panel.

Using the WELDS Counter

1. Press this button for about 1 second and wait for the green LED on the button to go ON. When it does, the 6-digit **COUNTER** display will show the total number of welds the Power Supply has made since the last time it was reset to zero.
2. To reset this counter, press the **CLEAR** button for about 1 second and the 6-digit display will reset to **zero**.

Using LIMIT SET

This feature is useful for counting weld made on a set of electrodes to determine when to change electrodes. This feature can also be used to count the number of welds during a particular shift or work day. After the limit is reached, the Power Supply will "beep" each time a weld is made. This signals the Operator to take action.

1. Press the **LIMIT SET** button and wait for the green LED on the button to go ON. When it does, the 6-digit **COUNTER** display will show the **limit set** for the number of welds made.
2. To change the **LIMIT SET** number, press this button for about 1 second and wait for the 6-digit display to flash. When it flashes, you can then press the ▲▼ arrows to increase or decrease the number of welds for **LIMIT SET**.
3. To accept the changes, press the **LIMIT SET** button again and the LED will stop flashing. To exit the "editing" mode ***without*** accepting changes, ***press any other button*** on the front panel.

Chain Schedules 1 & 2

1. Use the ▲▼ arrows to select weld Schedule 1 and Schedule 2 in order to verify that each schedule displays the values you want to use. If not, follow the **Modify Weld Schedules** procedures above.
2. After you have verified that Schedule 1 and Schedule 2 are correct, press and hold the **CHAIN SCH 1-2** button for about 1 second and verify that the green light on the switch is ON. The **CHAIN SCH 1-2** button will "chain" Schedule 1 and Schedule 2 together, meaning welding pulses will alternate between these two schedules. The green light on this switch will remain ON while the "chain" function is in use. The control will switch to Schedule 1**.**
3. Press the **WELD/NO WELD** switch to the **WELD** position.
4. Begin welding using your normal procedures. Welding will continue repeating between these schedules until you press and hold the **CHAIN SCH 1-2** button again for about 1 second until the green light on the button goes OFF.

Dual weldhead operation

1. Follow the procedure above to chain Schedule 1 and Schedule 2 together.
2. Connect weldhead 1 to the 4 pin Standard Air Valve Driver Output Connector.
3. Connect Weldhead 2 to the 8 pin Weld Head Connector.
4. Connect the Dual Weldhead Input (pin 13 on the 37 pin connector) to the I/O common (pin 32 on the 37 pin connector).
5. Schedule 1 will then use weldhead 1 and schedule 2 will use weldhead 2. These two heads and schedules will fire alternately with the FS input.

Programming Lock

The programmed values of the 15 schedules can be locked so that no changes are possible. To set this lock, connect pin 9 of the 37 pin connector to the I/O common. See *Appendix B* for connection details. Note that the schedule numbers can still be changed, but the values stored in each schedule cannot be changed.

Schedule Lock

The programmed values of the 15 schedules and the schedule number itself can be locked so that no changes are possible. To set this lock, connect pin 27 of the 37 pin connector to the I/O common. See *Appendix B* for connection details.

Section 3: Operational Notes

Repetition Rate

The user must maintain the repetition rate of the unit at or below that listed in Appendix A. Short burst of 2 or 4 welds may be fired at a more rapid pace, but the number of welds per minute listed must not be exceeded.

Automatic Power Turn-Down

The user must limit the power dissipated in the automatic turn-down circuit to the 50W limit listed in Appendix A. Rapid firing of different schedules with significantly different energy level can exceed this limit. To calculate the total power dissipated in this circuit:

1. Determine how many times in one minute the schedule will change from a higher energy to a lower energy.
2. Add up the total Watt-seconds of energy decrease in one minute.
3. Divide this number by 60 to determine the average Watts of power dissipated

   Example: If there are 12 schedule changes per minute where the programmed energy decreases from 300Watt-seconds to 100Watt-seconds, the total change is 2400 Watt-seconds per minute. Dividing by 60 gives a resultant value of 40 Watts (Watt-seconds per second equals Watts), which is within the capability of the unit.

Open Load Protection

CAUTION

When the unit is fired with an open secondary circuit, the energy from the capacitor bank is ***not*** delivered to the weld. Instead, it is absorbed by the internal circuitry of the welder. If the unit were allowed to fire repeatedly into an open load, it could cause internal circuits to overheat and be damaged.

In order to prevent this potential failure mode, the unit has an overload protection feature. When an open load is detected by the unit, the firing circuit is quickly turned OFF and the unit will display ERR 12 in the 6-digit display.

The threshold for detecting an open load is typically about 15 milliohms. If your application requires operation with a secondary circuit that exceeds this resistance, please contact Miyachi Unitek for assistance.

CHAPTER 4
Maintenance

Section I. Troubleshooting

Troubleshooting

Problem	Cause (in order of probability)	Problem	Cause (in order of probability)
Electrode Damage	1. Excessive energy set at 100DP/300DP 1. Excessive or insufficient weld head force 1. Wrong electrode tip shape 2. Contaminated weld piece surface/ plating 2. Excessively short pulse time set at 100DP/300DP 2. Wrong electrode material 2. Contaminated electrode surface	Electrode Sparking	1. Excessive energy set at 100DP/300DP 1. Insufficient weld head force 1. Slow weld head follow-up 1. Incompatible weld piece projection design 1. Contaminated weld piece surface/ plating 1. Wrong electrode tip shape 2. Excessively short pulse time set at 100DP/300DP 2. Wrong electrode material 2. Contaminated electrode surface
Electrode Sticking	1. Contaminated weld piece surface/ plating 1. Wrong electrode material/ tip shape 1. Insufficient weld head force 2. Excessive energy set at 100DP/300DP 2. Contaminated electrode surface 3. Slow weld head follow-up	Weld Piece Warping	1. Excessive weld time set at 100DP/300DP 1. Excessive weld head force 1. Incompatible weld piece projection design 2. Incompatible weld piece materials 2. Wrong electrode tip shape 3. Excessive current/energy set at 100DP/300DP
Insufficient Weld Nugget	1. Insufficient energy set at 100DP/300DP 1. Wrong electrode material/ tip shape 1. Worn/mushroomed electrodes 2. Excessively long pulse time set at 100DP/300DP 2. Incorrect weld head polarity 2. Contaminated weld piece surface/ plating 2. Excessive weld head force 3. Insufficient weld head force 3. Contaminated electrode surface 3. Incompatible weld piece projection design 3. Slow weld head follow-up 4. Incompatible weld piece materials 4. No cover gas on weld piece	Metal Expulsion	1. Excessive current/energy set at 100DP/300DP 1. Insufficient weld head force 1. Slow weld head follow-up 1. Incompatible weld piece projection design 2. Contaminated weld piece surface/ plating 2. Incompatible weld piece materials 2. Contaminated electrode surface 2. Wrong electrode tip shape 3. No cover gas on weld piece 4. Excessively short weld time set at 100DP/300DP

Problem	Cause (in order of probability)	Problem	Cause (in order of probability)
Weld Piece Over-heating	1. Excessive energy set at 100DP/300DP 2. Insufficient weld head force 3. Incompatible weld piece materials 3. Wrong electrode material/tip shape 4. Contaminated electrode surface	Weld Piece Discoloration	1. No cover gas on weld piece 2. Excessive energy set at 100DP/300DP 3. Insufficient weld head force 3. Contaminated weld piece surface/ plating 4. Wrong electrode material/tip shape 4. Contaminated electrode surface

Error Codes

The Control displays the following error codes in the 6 digit counter display. The error codes are in the format "ERR 01", "ERR02" and so on. To clear an error code, press and hold the **CLEAR** button for 2 seconds. Error descriptions and typical troubleshooting steps are shown below. 1)

Error Number	Error Name	Description	Troubleshooting Steps
1	Capacitor Discharge timeout	The energy setting in the weld schedule was reduced, or the schedule number was changed to a schedule with a lower energy setting. The unit did not reach this new, lower energy value within 15 seconds.	1) Turn off the unit and wait 30 seconds. Turn on the unit and see if the error disappears. 2) If the error persists, contact Miyachi Unitek for service.
2	Capacitor Charge timeout	The capacitors did not reach the programmed energy level within 500 msec.	1) Verify that the AC line voltage is within limits. 2) If the AC voltage is within limits and the error persists, contact Miyachi Unitek for service.
3	Firing Switch timeout	The firing switch did not close within 10 seconds of FS2 closing.	Adjust the weldhead and/or parts to be welded so that the firing switch closes within 10 seconds of FS2 closing.
4	Calibration value out of limits	The value of the capacitance entered during calibration is out of limits.	Contact Miyachi Unitek for service.
5	Memory write error.	The internal memory writing process did not complete within 1 second	Contact Miyachi Unitek for service.
6	Memory error	The values stored in memory have been corrupted. Default values have been reloaded into the unit.	Contact Miyachi Unitek for service

Error Number	Error Name	Description	Troubleshooting Steps
7	Blown fuse	The internal fuse in the unit has been blown.	1) Verify that the unit is plugged into the correct AC voltage 2) Contact Miyachi Unitek for service
8	Internal communication error	An error occurred in the internal communication between the front panel and control board.	Contact Miyachi Unitek for service
12	Open load detected	The resistance of the secondary circuit is too high.	1) Verify that the weldhead is closed when the unit fires. 2) Verify that the weld cables are tightly connected 3) Verify that the electrode is properly installed in the weldhead 4) If the process requires operation with a high secondary circuit resistance, contact Miyachi Unitek for assistance

Section II. Maintenance

Calibration

Calibration must be performed by factory-trained and qualified personnel. If your Power Supply needs calibration, contact your local Miyachi Unitek service representative, or contact our service department at the address, phone number, or e-mail address listed under **Contact Us** in the front of this manual.

Electrode Maintenance

When a welding schedule has been suitable for a particular welding application over many welds, but poor quality welds are now resulting, electrode deterioration could be the problem. If you need to increase welding current to maintain the same weld heat, the electrode tip has probably increased in surface area (mushroomed), effectively increasing weld current density, thus cooling the weld. Try replacing the electrodes.

The rough surface of a worn electrode tip tends to stick to the work pieces. So, periodic tip resurfacing (dressing) is required to remove pitting, oxides and welding debris from the electrode. You should limit cleaning of an electrode on the production line to using a #400-600 grit electrode polishing disk. If you must clean a badly damaged tip with a file, you must use a polishing disk after filing to ensure the electrode faces are smooth.

The best method of preventing electrode problems is to regularly re-grind electrode tip surfaces and shapes in a certified machine shop.

Parts Replacement

Below is a list of the replacement parts for the Control. All items listed are a quantity of 1 each.

WARNING: Only qualified technicians should perform internal adjustments or replace parts. Removal of the unit cover could expose personnel to high voltage and may void the warranty.

Part Description	Part No.	Location
Overvoltage Protection Fuse F1	330-197	Power PCB

Section III. Repair Service

If you have problems with your Control that you cannot resolve, please contact our service department at the address, phone number, or e-mail address listed under **Contact Us** in the front of this manual.

APPENDIX A
Technical Specifications

NOTE: The specifications listed in this appendix may be changed without notice.

Item	Description
Dimensions	
Weight	300DP 66 lbs (30 kg) 100DP 37 lbs (17kg)
Input line voltage	85 - 138 VAC 50 or 60 Hz 180 - 264 VAC 50 or 60 Hz
Overvoltage Detection	Internal fuse
Input VA (Max demand)	1300 VA
Charge circuit type	Switched mode
Weld Capacitor Charge Voltage	430 V max
Weld Capacitance	As required to achieve Output Energy
Output Energy Max per pulse	100DP -- 100Ws 300DP 300Ws
Voltage turndown circuit	50W average power. Automatic turndown upon power interruption

APPENDIX A: TECHNICAL SPECIFICATIONS

Item	Description
Repetition Rate (Single Pulse – in pulses per minute)	Energy 100DP 300DP 1Ws 320/min 3Ws 750/min 10Ws 240/min 520/min 25Ws 170/min 345/min 50Ws 110/min 240/min 75Ws 85/min 200/min 100Ws 75/min 175/min 150Ws 140/min 200Ws 120/min 225Ws 105/min 300Ws 80/min
Rise Times at Max Energy	100DP 300DP Very Short (**VS**) 0.6 ms 0.9 ms Short (**S**) 0.6 ms 1.0 ms Medium (**M**) 0.8 ms 1.5 ms Long (**L**) 1.2 ms 1.6 ms
Weld schedules	15
Weld pulses per Schedule	2
Watt Second Adjustment Range	100DP -- 1 to 100 Watt Seconds (Ws) 300DP -- 3 to 300 Watt Seconds (Ws)
Polarity Selection	Positive, Negative, or Alternating
Squeeze Time	0-2999 msec
Hold Time	0-2999 msec
Weld Counter	0-999999
Action Upon Reaching Limit	Buzzer sounds after each weld. Output relay activates.
Input Debounce Time	32 msec
Control Outputs (See Appendix B for details)	Weld ready (24VAC or 30VDC max, 500mA max) Weld end (24VAC or 30VDC max, 500mA max) Counter reached limit (24VAC or 30VDC max, 500mA max) 24 VDC and return (for optical firing switch)
Environmental Operating Humidity Operating Temperature	 5% to 95% (Non-condensing) 5°C to 40°C (Ambient Temperature)
Valve power	24 VAC, 1A maximum. 24 VDC 1A maximum, including any current drawn from pins 1 and 19 of the 37 pin I/O connector.

Ship Kit Contents

1) 37-pin mating connector with hood.

APPENDIX B
Electrical and Data Connections

Section I. Electrical Connection

Input Power

As described in *Chapter 2*, you need to supply an AC power cord. The female end of the power cable is an IEC-320-C13 standard plug. The length of the cord and the male end are as required in your local installation.

Connect the Power Supply power cable to a 1-phase, 50/60Hz power source. The voltage range for each model is set at the factory. If you wish to change the operating voltage of your unit, please contact Miyachi Unitek Corporation for the required components and installation instructions. See **CONTACT US** in the front of this manual for contact information.

CAUTION

Be sure that the AC power is the correct voltage for your Power Supply model.

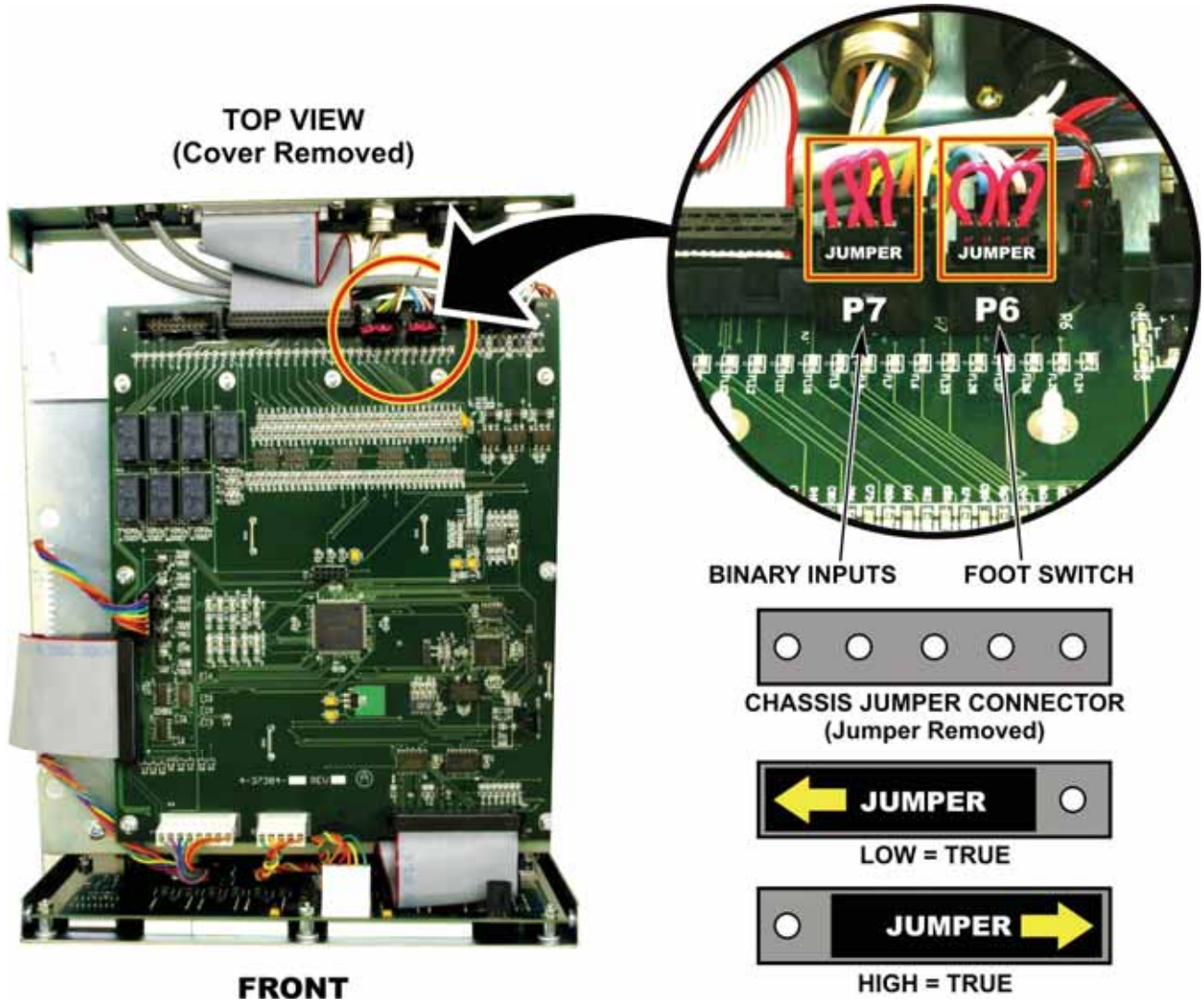
Section II. External Input/Outputs

Input Logic Configuration

The unit is shipped from the factory configured for **LOW = TRUE INPUTS**. This is a common set up when using a switch closure to ground-to-activate, or to turn an input ON. The unit can also be configured for **HIGH = TRUE INPUTS**. This is a common set up for using a PLC or other external device to supply +24VDC-to-activate or to turn an input ON. This configuration is accomplished by changing two jumpers.

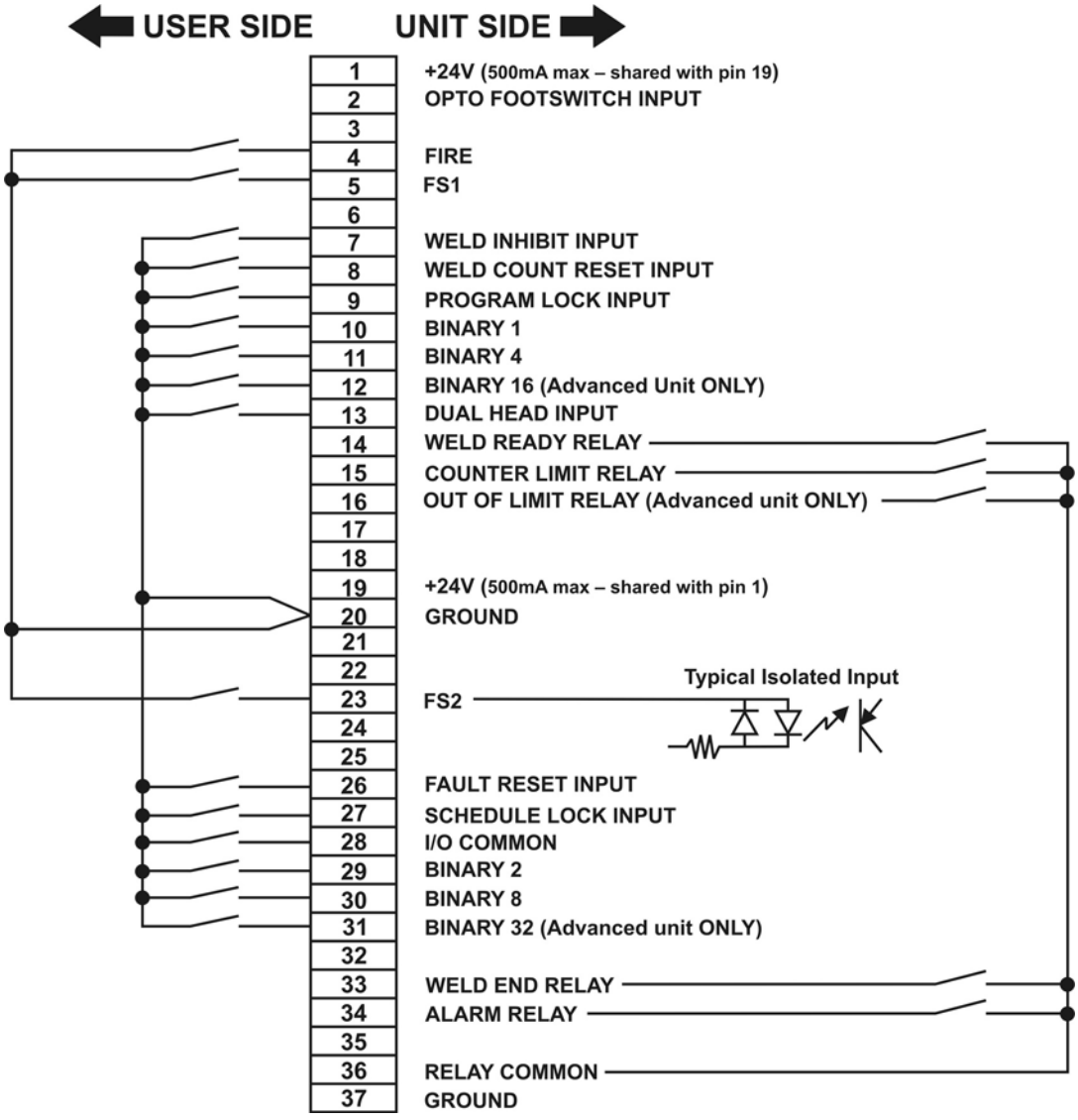
To replace the footswitch and firing switch with PLC or other **+24VDC = TRUE SIGNALS**, remove the cover of the unit and locate jumper **P6**. Move it to the **HIGH = TRUE** position as shown below. Note that this position is *only* used if Miyachi Unitek footswitch and weldhead firing switch connections are replaced by **+24VDC = TRUE INPUTS**. If a Miyachi Unitek mechanical footswitch and standard weldhead firing switch are used, this jumper should remain in the **LOW = TRUE** position.

To reconfigure all other inputs (Binary schedule select lines, weld inhibit, etc.) for **HIGH = TRUE**, move jumper **P7** to the **HIGH = TRUE** position as shown in the photograph.



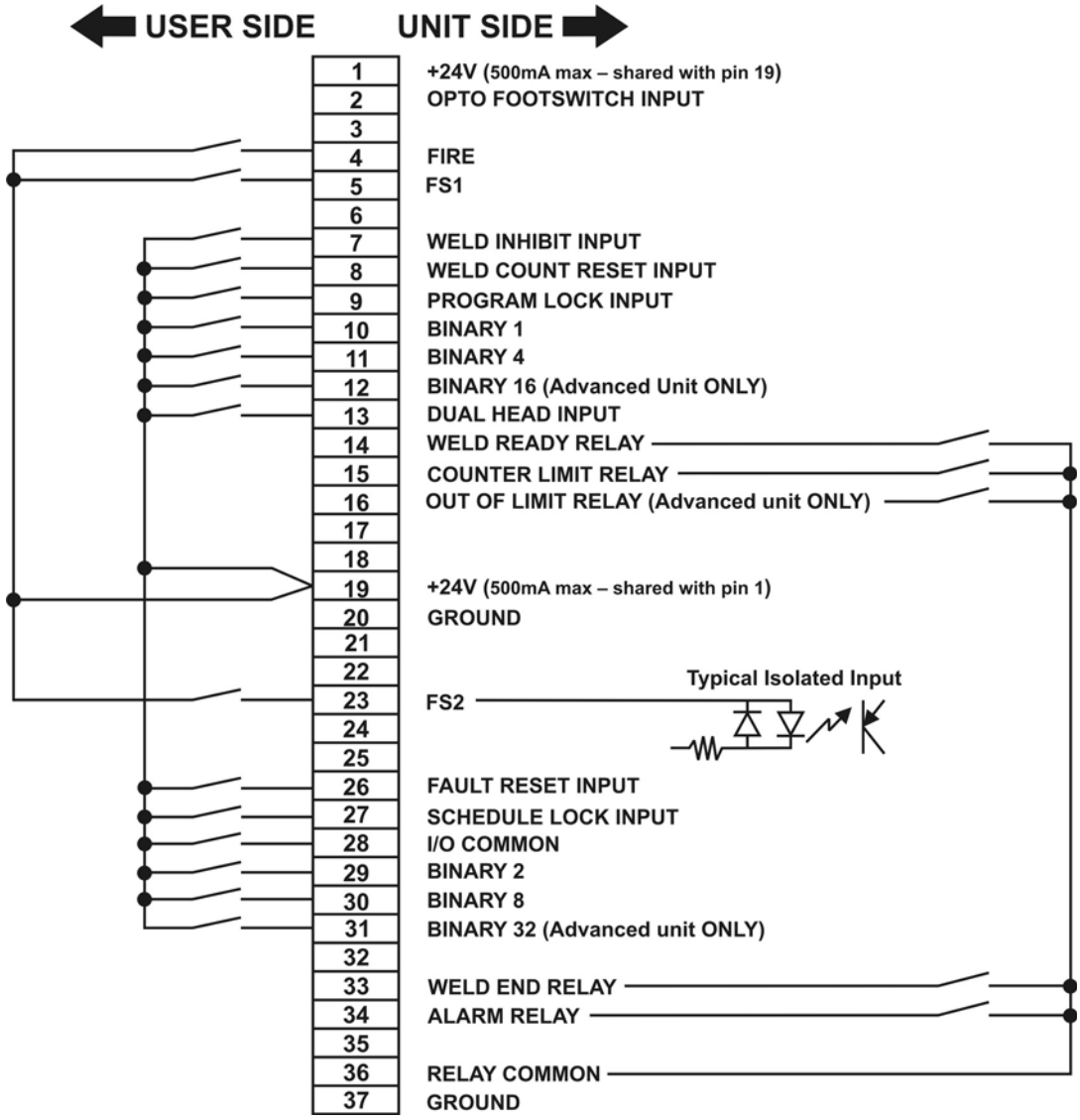
Configuration for Low = True Inputs

(Switch Closure to Activate Inputs)



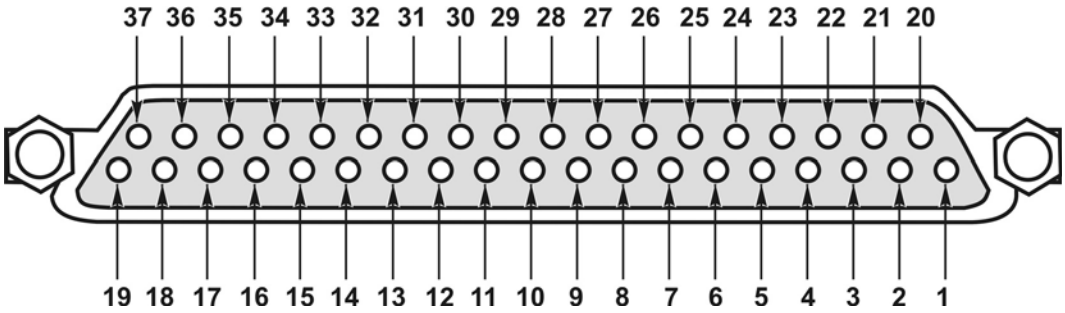
Configuration for High = True Inputs

(PLC or +24V to Activate Inputs)



I/O Signal Interface General Description

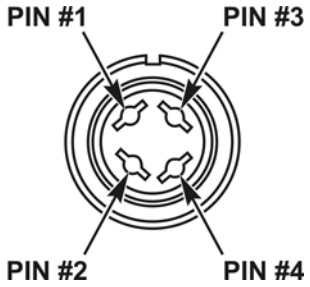
37-Pin Connector



Pin No.	Description
1	+24VDC. The total current draw from pins 1 and 19 must not exceed 500 mA.
2	Optical firing switch input
3	Not used
4	Firing switch input
5	FS1 (Foot switch level 1) input
6	Not used
7	Weld inhibit input
8	Weld counter reset input
9	Program lock input
10	Binary schedule select bit 1
11	Binary schedule select bit 4
12	Binary schedule select bit 16 (not available on all models)
13	Dual weldhead input
14	Weld ready relay output
15	Counter exceeds limit relay output
16	Weld out of limits relay (not available on all models)
17	Not used
18	Not used
19	+24VDC. The total current draw from pins 1 and 19 must not exceed 500 mA.
20	Ground
21	Not used
22	Not used
23	FS2 (Foot switch level 2)

Pin No.	Description
24	Not used
25	Not used
26	Fault reset input
27	Schedule lock input
28	Not used
29	Binary schedule select bit 2
30	Binary schedule select bit 8
31	Binary schedule select bit 32 (not available on all models)
32	I/O common
33	Weld end relay output
34	Alarm relay output (not available on all models)
35	Not used
36	Relay common
37	Ground

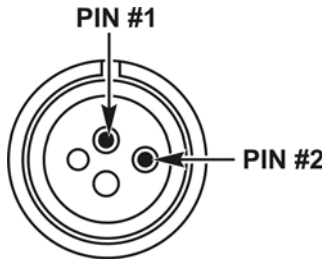
Two-Level Foot Switch Connector

Foot Switch Connector		
Pin	**Description**	
1	Chassis Ground	
2	Foot_1 (to activate Foot Switch Level 1, connect to pin 4)	
3	Foot_2 (to activate Foot Switch Level 2, connect to pin 4)	
4	24COM	

When you press the foot switch to the first level, the Power Supply energizes the air actuated weld head. This causes the upper electrode to descend and apply force to the weld pieces. If you release the foot switch before pressing it to the second level, the Power Supply will automatically return the upper electrode to its UP position so that you may re-position the weld pieces.

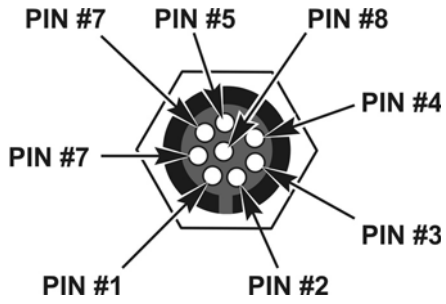
If you do not release the foot switch at the first level and proceed to the second level, the force-firing switch in the weld head will close. Weld current will flow, and the Power Supply will automatically return the upper electrode to its UP position.

Standard Air Valve Driver Output Connector

Air Valve Driver 24 VAC Connector		
Pin	**Description**	
1	24VAC (for solenoid)	
2	HEAD_1 (Switched 24V common)	

The air valve driver output (24VAC) is initiated when Foot Switch Level 1 is initiated. If a PLC or other means of trigger is used, refer to the *I/O Signal Interface General Description* on page B-3. The mating connector is an AMP type 206429-1, using cable clamp AMP type 206358-2. The two male pins used are Amp type 66361-2.

Weld Head Connector

Weld Head Connector		
Pin	**Description**	
1	HEAD_1 (switched 24V common for solenoid)	
2	24V_OUT (24VDC for solenoid)	
3	24COM	
4	FIRE_1	
5	VOLT_IN	
6	VOLT_COM	
7	AIRHEAD	
8	Not used	

The Weld Head Connector combines all the inputs and outputs necessary to connect a plug-and-play *EZ-AIR* Miyachi Unitek weld head. If PLC or other means of trigger is used, refer to the *I/O Signal Interface General Description* on page B-3.

Operator Emergency Stop Cable Switch Input

Function

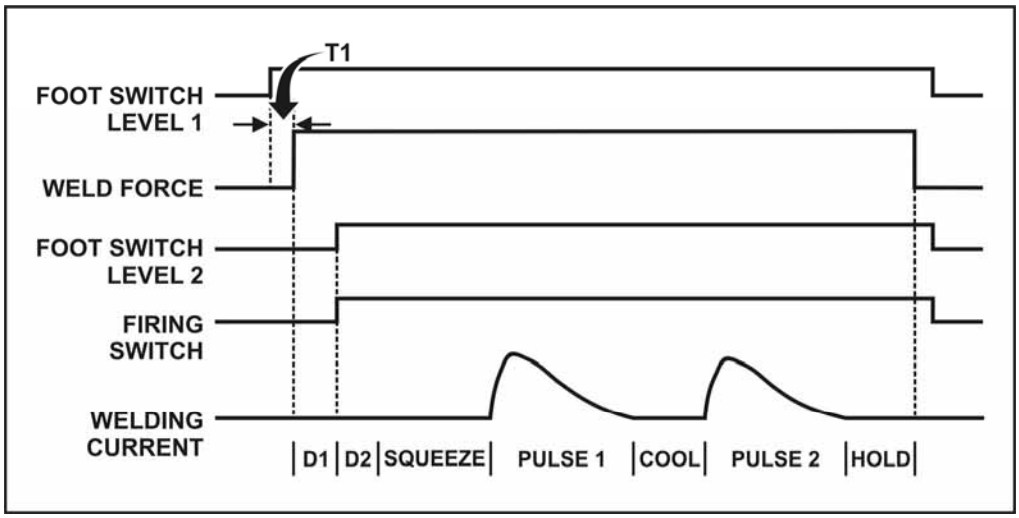
You ***must*** connect a normally closed, single-pole switch across both cable leads, otherwise the Power Supply cannot be turned ON. Use the switch during Power Supply operation as an **Emergency Stop Switch**. When operated (opened), it will immediately halt the weld process.

Connections

Connect an approved, normally closed emergency stop switch across the 2-foot (61 cm) operator Emergency Stop Switch cable. When the switch is operated (opened), it de-energizes all power outputs from the Power Supply.

APPENDIX C
System Timing

Basic Weld Operation: Air Head System with Two-Level Foot Switch



Definitions

T1 Delay time from Foot Switch Level 1 closure to Weld Force start. Maximum delay time is 40 ms.

D1 Delay time from Weld Force start to Firing Switch closure. Maximum D1 time is 10 seconds. If the firing switch does not close within 10 seconds, the message **FIRING SWITCH DIDN'T CLOSE IN 10 SECONDS** will be displayed.

D2 Delay time from Firing Switch closure and Foot Switch Level 2 closure to squeeze time (**SQZ**). Maximum D2 time is 40 ms.

SQZ Squeeze time. Selectable range is 0 to 2999 ms.

Pulse 1 The timing of this weld pulse depends upon the pulse length programmed, the energy setting and the impedance of the secondary circuit

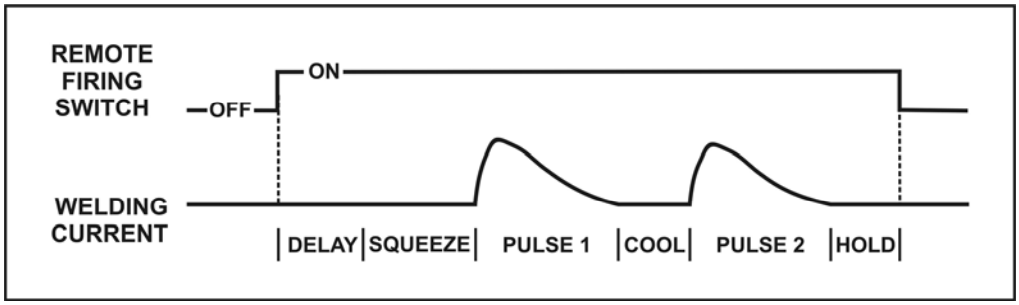
COOL This time is not programmable by the user. It depends upon the energy level of the second pulse, and ranges from 20 to 670 msec. If no second pulse is programmed, this time period is skipped.

Pulse 2 The timing of this weld pulse depends upon the pulse length programmed, the energy setting and the impedance of the secondary circuit

HOLD Hold time. Selectable range is 0 to 2999 ms.

NOTE: The inputs signals (FS1, FS2 and firing switch) need to be ***at least 50 msec duration*** for the unit to recognize them.

Basic Weld Operation: Manual Head System with Firing Switch Operation



Definitions

DELAY Delay time from firing switch closure to the start of the weld sequence (that is, start of **SQZ**). Maximum **DELAY** time is 40 msec.

SQZ Squeeze time. Selectable range is 0 to 2999 ms.

Pulse 1 The timing of this weld pulse depends upon the pulse length programmed, the energy setting and the impedance of the secondary circuit

COOL This time is not programmable by the user. It depends upon the energy level of the second pulse, and ranges from 20 to 670 msec. If no second pulse is programmed, this time period is skipped.

Pulse 2 The timing of this weld pulse depends upon the pulse length programmed, the energy setting and the impedance of the secondary circuit

HOLD Hold time. Selectable range is 0 to 2999 ms.

NOTE: The firing switch signal needs to be ***at least 50 msec duration*** for the unit to recognize it.

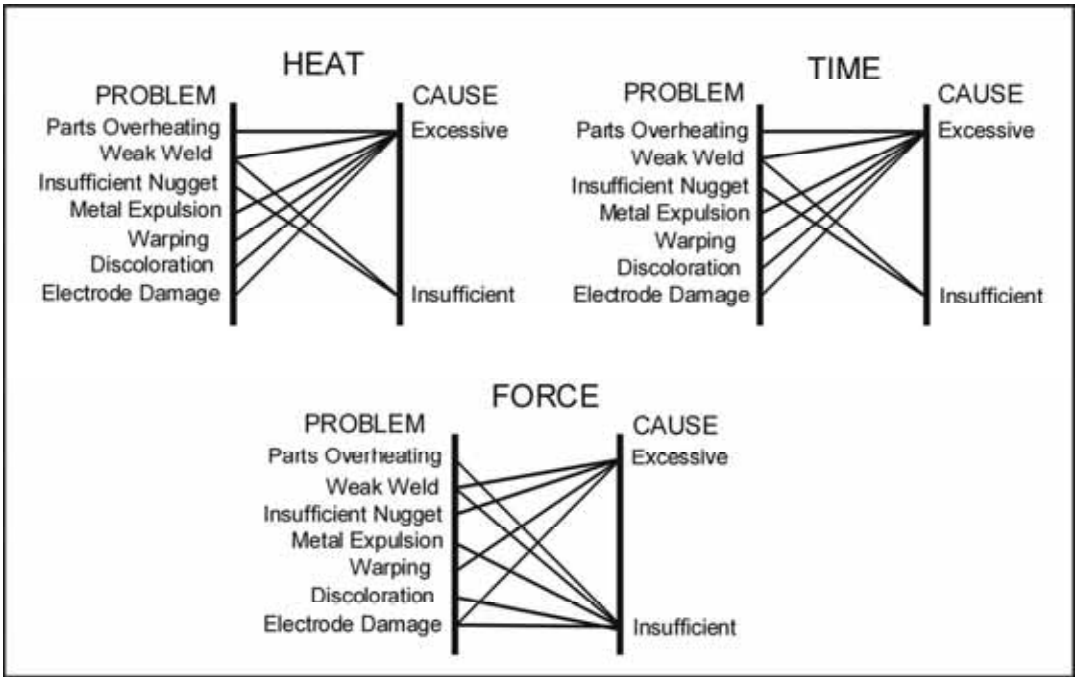
APPENDIX D
The Basics Of Resistance Welding

Resistance Welding Parameters

Resistance welding heat is produced by passing electrical current through the parts for a fixed time period. The welding heat generated is a function of the magnitude of the weld current, the electrical resistance of the parts, the contact resistance between the parts, and the weld force applied to the parts. Sufficient weld force is required to contain the molten material produced during the weld. However, as the force is increased, the contact resistance decreases. Lower contact resistance requires additional weld current, voltage, or power to produce the heat required to form a weld.

The higher the weld force, the greater the weld **current**, **voltage**, **power**, or **time** required to produce a given weld. The formula for amount of heat generated is $\mathbf{I^2RT}$ -- the square of the weld current [**I**] times the workpiece resistance [**R**] times the weld time [**T**].

Welding Parameter Interaction



Interaction of Welding Parameters

Electrode Selection

Correct electrode selection strongly influences how weld heat is generated in the weld area. In general, use conductive electrodes such as a RWMA-2 (Copper alloy) when welding electrically resistive parts such as nickel or steel so that the weld heat is generated by the electrical resistance of the parts and the contact resistance between the parts. Use resistive electrodes such as RWMA-13 (Tungsten) and RWMA-14 (Molybdenum) to weld conductive parts such as copper and gold because conductive parts do not generate much internal heat so the electrodes must provide external heat. Use the following Electrode Selection Table for selecting the proper electrode materials.

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Alumel	-2	Alumel	-2
Alumel	-2	Chromel	-2
Alumel	-2	Dumet	-2
Aluminum	-1	Aluminum	-1
Aluminum	-1	Aluminum Alloys	-1
Aluminum	-1	Cadmium Plating	-1
Aluminum	-1	Tinned Brass	-14
Aluminum	-1	Tinned Copper	-14
Aluminum	-1	Gold Plated Dumet	-2
Aluminum	-1	Gold Plated Kovar	-2
Aluminum	-1	Kovar	-2
Aluminum	-1	Magnesium	-1
Aluminum	-1	Cold Rolled Steel	-2
Aluminum	-1	Stainless Steel	-2
Beryllium Copper	-2	Beryllium Copper	-2
Beryllium Copper	-2	Brass	-2, -14
Beryllium Copper	-2	Copper	-14
Beryllium Copper	-2	Tinned Copper	-14
Beryllium Copper	-2	Nickel	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Beryllium Copper	-2	Cold Rolled Steel	-2
Beryllium Copper	-2	Stainless Steel	-2
Brass	-2, -14	Brass	-2, -14
Brass	-2, -14	Tinned Brass	-14
Brass	-2, -14	Consil	-2
Brass	-2, -14	Constantan	-2
Brass	-2, -14	Copper	-14
Brass	-2, -14	Tinned Copper	-14
Brass	-2, -14	Dumet	-2
Brass	-2, -14	Nichrome	-2
Brass	-2, -14	Nickel	-2
Brass	-2, -14	NiSpan C	-2
Brass	-2, -14	Paliney 7	-2
Brass	-2, -14	Silver	-11, -14
Brass	-2, -14	Cold Rolled Steel	-2
Brass	-2, -14	Stainless Steel	-2
Bronze	-2, -11	Bronze	-2, -11
Bronze	-2, -11	Tinned Copper	-14
Bronze	-2, -11	Iron	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Bronze	-2, -11	Nichrome	-2
Bronze	-2, -11	Nickel	-2
Chromel	-2	Chromel	-2
Chromel	-2	Constantan	-2
Chromel	-2	Copel	-2
Chromel	-2	Copper	-14
Chromel	-2	Tinned Copper	-14
Chromel	-2	Dumet	-2
Chromel	-2	Nichrome	-2
Chromel	-2	Cold Rolled Steel	-2
Consil	-2	Consil	-2
Consil	-2	Tinned Copper	-14
Consil	-2	Dumet	-2
Constantan	-2	Constantan	
Constantan	-2	Copper	-14
Constantan	-2	Tinned Copper	-14
Constantan	-2	Iron	-2
Constantan	-2	Nichrome	-2
Constantan	-2	Nickel	-2
Copper	-14	Copper	-14
Copper	-14	Dumet	-2
Copper	-14	Invar	-2
Copper	-14	Karme	-2
Copper	-14	Manganin	-2
Copper	-14	Nichrome	-2
Copper	-14	Nickel	-2
Copper	-14	Paliney 7	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Copper	-14	Silver	-11, -14
Copper	-14	Cold Rolled Steel	-2
Copper	-14	Stainless Steel	-2
Dumet	-2	Dumet	-2
Dumet	-2	Nichrome	-2
Dumet	-2	Nickel	-2
Dumet	-2	Platinum	-2
Dumet	-2	Cold Rolled Steel	-2
Evanohm	-14	Copper	-14
Gold	-14	Gold	-14
Gold	-14	Kovar	-2
Hastalloy	-2	Titanium	-2
Inconel	-2	Inconel	-2
Inconel	-2	Kulgrid	-2
Invar	-2	Invar	-2
Iridium	-2	Iridium	-2
Iridium	-2	Platinum	-2
Iron	-2	Iron	-2
Karma	-2	Karma	-2
Karma	-2	Nickel	-2
Karma	-2	Platinum	-2
Kovar, Gold Plate	-2	Kovar, Gold Plate	-2
Kovar, Gold Plate	-2	Kulgrid	-2
Kovar, Gold Plate	-2	Nickel	-2
Kovar, Gold Plate	-2	Silver	-11, -14
Kovar, Gold Plate	-2	Stainless Steel	-2
Magnesium	-1	Magnesium	-1

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Molybdenum	-2	Nickel	-2
Molybdenum	-2	Tungsten	-2
Nichrome	-2	Nichrome	-2
Nichrome	-2	Nickel	-2
Nichrome	-2	Cold Rolled Steel	-2
Nichrome	-2	Stainless Steel	-2
Nickel	-2	Nickel	-2
Nickel	-2	Cold Rolled Steel	-2
Nickel	-2	Stainless Steel	-2
Nickel	-2	Tantalum	-2
Nickel	-2	Tungsten	-2
Nickel Alloy	-2	Nickel Alloy	-2
Nickel Alloy	-2	Tinned Brass	-14
Nickel Alloy	-2	Beryllium Copper	-2
Nickel Alloy	-2	Consil	-2
Nickel Alloy	-2	Tinned Copper	-14
Nickel Alloy	-2	Nichrome	-2
Nickel Alloy	-2	Nickel	-2
Nickel Alloy	-2	Cold Rolled Steel	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
NiSpan C	-2	NiSpan C	-2
NiSpan C	-2	Cold Rolled Steel	-2
NiSpan C	-2	Stainless Steel	-2
Niobium	-2	Niobium	-2
Platinum	-2	Platinum	-2
Paliney 7	-2	Paliney 7	-2
Silver	-11, -14	Silver	-11, -14
Silver	-11, -14	Cadmium	-13
Cold Rolled Steel	-2	Cold Rolled Steel	-2
Cold Rolled Steel	-2	Stainless Steel	-2
Cold Rolled Steel	-2	Tantalum	-2
Stainless Steel	-2	Stainless Steel	-2
Stainless Steel	-2	Tungsten	-2
Tantalum	-2	Tantalum	-2
Titanium	-2	Titanium	-2
Tungsten	-2	Tungsten	-2
Tungsten	-2	henium	-2
Zinc	-14	Zinc	-14

Electrode Maintenance

Depending on use, periodic tip resurfacing is required to remove oxides and welding debris from electrodes. Cleaning of electrodes on production line should be limited to use of #400-600 grit electrode polishing disks. For less critical applications, a file can be used to clean a badly damaged tip. However, after filing, polishing disks should then be used to ensure that the electrode faces are smooth. If this is not done, the rough surface of the electrode face will have a tendency to stick to the work piece.

Weld Schedule Development

Developing a weld schedule is a methodical procedure, which consists of making sample welds and evaluating the results. The first weld should be made at low energy settings. Adjustments are then made to each of the welding parameters ***one at a time*** until a successful weld is made.

1 Install the correct electrodes in the electrode holders on the Weld Head. See the preceding Table for electrode material recommendations.

2 Use a flat electrode face for most applications. Use a "domed" face if surface oxides are a problem. If either of the parts is a wire, the diameter of the electrode face should be equal to or greater than the diameter of the wire. If both parts are flat, the face should be at least one-half the diameter of the electrodes. Pencil point electrodes cause severe electrode sticking to the parts, unexplained explosions, and increase the weld heat substantially because of the reduced electrode-to-part contact area.

3 Use the Force Adjustment Knob on the Weld Head to set the Firing Force and adjust an Air Actuated Weld Head.

4 Program a weld schedule, then make your first weld. Always observe safety precautions when welding and wear safety glasses. For a complete procedure on making welds, refer to *Operating Instructions*.

5 Use pliers to peel the welded materials apart. A satisfactory weld will show residual material pulled from one material to the other. Tearing of base material around the weld nugget indicates a material failure NOT a weld failure. Excessive electrode sticking and/or "spitting" should define a weld as unsatisfactory and indicates that too much weld current, voltage, power, or time has been used.

6 If the parts pull apart easily or there is little or no residual material pulled, the weld is weak. Increase the weld time in 1 msec increments. Increase weld current, voltage, or power if a satisfactory weld achieved using 10 msec of weld time.

NOTE: Actual weld strength is a user-defined specification.

7 Polarity, as determined by the direction of weld current flow, can have a marked effect on the weld characteristics of some material combinations. This effect occurs when welding materials with large differences in resistivity, such as copper and nickel or when welding identical materials with thickness ratios greater than 4 to 1. The general rule is that the more resistive material or the thinner material should be placed against the negative (-) electrode. Polarity on the Control can only be changed by reversing the Weld Cables.

Weld Strength Testing

Destructive tests should be performed on a random basis using actual manufacturing parts. Destructive tests made on spot welds include tension, tension-shear, peel, impact, twist, hardness, and macro-etch tests. Fatigue tests and radiography have also been used. Of these methods torsional shear is preferred for round wire and a 45-degree peel test for sheet stock.

Weld Strength Profiles

Creating a weld strength profile offers the user a scientific approach to determining the optimum set of welding parameters and then displaying these parameters in a graphical form.

1 Start at a low weld current, voltage, or power, making five or more welds, then perform pull tests for each weld. Calculate the average pull strength. Increase weld current, voltage, or power and repeat this procedure. Do not change the weld time, weld force, or electrode area.

2 Continue increasing weld current, voltage, or power until any unfavorable characteristic occurs, such as sticking or spitting.

3 Repeat steps 1 through 3 for different weld forces, then create a plot of part pull strength versus weld current, voltage, or power for different weld forces as shown in the illustration on the next page, *Typical Weld Strength Profile*.

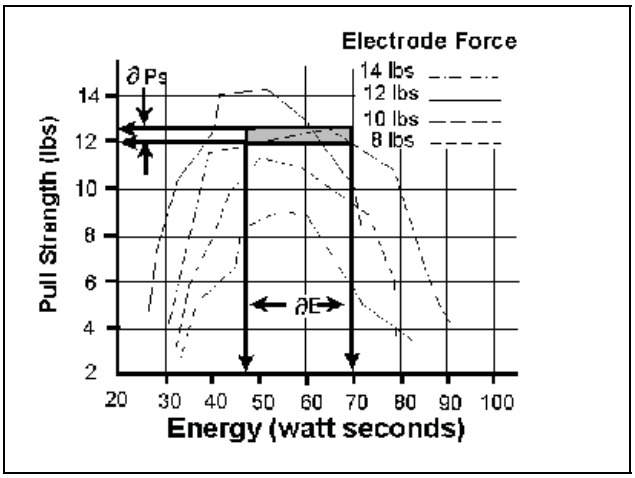
4 Repeat steps 1 through 3 using a different but fixed weld time.

Typical Weld Strength Profile

The picture on the right illustrates a typical weld strength profile. The 14 lb electrode force curve shows the highest pull strengths but the lowest tolerance to changes in weld current, voltage, or power. The 12 lb electrode force curve shows a small reduction in pull strength, but considerably more tolerance to changes in weld energy. Weld heat will vary as a result of material variations and electrode wear.

The 12 lb electrode force curve is preferred. It shows more tolerance to changes in weld current, voltage, or power and has nearly the same bond strength as the 14 lb electrode force curve.

A comparison of weld schedules for several different applications might show that they could be consolidated into one or two weld schedules. This would have obvious manufacturing advantages.



Typical Weld Strength Profile

APPENDIX E

Quality Resistance Welding Solutions: Defining the Optimum Process

Introduction

A quality resistance welding solution both meets the application objectives and produces stable, repeatable results in a production environment. In defining the optimum process the user must approach the application methodically and consider many variables. In this article we will look at the following key stages and principles to be considered when defining the optimum resistance welding process:

- Materials and their properties
- Basic resistance welding
- principles
- Weld profiles
- Approach to development
- Common problems
- Use of screening DOE's
- Use of factorial DOE's

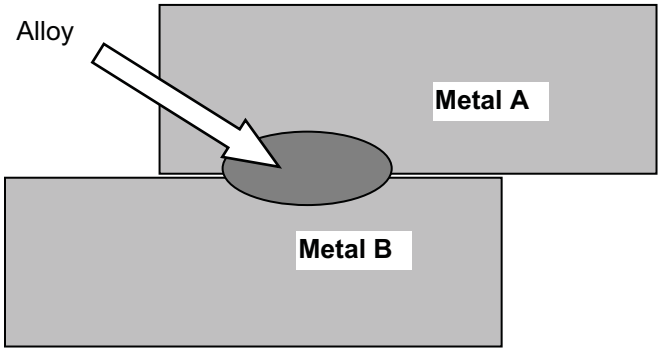
Resistance Welding -- A Material World

The first consideration in designing a quality welding solution is the properties of the materials to be joined and the quality requirements of the desired welded joint. At this stage, it is worthwhile to review the way the resistance welding process works and the likely outcome when the parts are resistance welded.

There are four main types of structural materials:

- Metals (silver, steel, platinum)
- Ceramic (alumina, sand)
- Plastics/polymers (PVC, teflon)
- Semiconductors (silicon, geranium)

Of these, only metals can be resistance welded because they are electrically conductive, soften on heating, and can be forged together without breaking.



Alloys are a mixture of two or more metals. An alloy is normally harder, less conductive, and more brittle than the parent metal which has bearing on the type of joint one can expect when resistance welding a combination of different metals.

Metals atoms are naturally attracted to other metal atoms even in different parent materials. Metals and alloys will bond together once surface contaminants such as dirt, grease, and oxides removed. Resistance welding generates heat at the material interface, which decomposes the dirt and grease and helps to break up the oxide film. The resultant heat softens or melts the metal and the applied force brings the atoms on either side into close contact to form the bond. The strength of the joint develops as it cools and a new structure is formed.

There are three main types of bonds that can be formed using the resistance welding process:

- **Solder or Braze Joint**

  A filler material such as a solder or braze compound is either added during the process or present as a plating or coating. Soldered joints are typically achieved at temperatures less than 400°C and brazed joints such as Sil-Phos materials melt at temperatures above 400°C.
- **Solid-State Joint**

  A solid state joint can be formed when the materials are heated to between 70-80% of their melting point.
- **Fusion Joint**

  A fusion joint can be formed when both metals are heated to their melting point and their atoms mix.

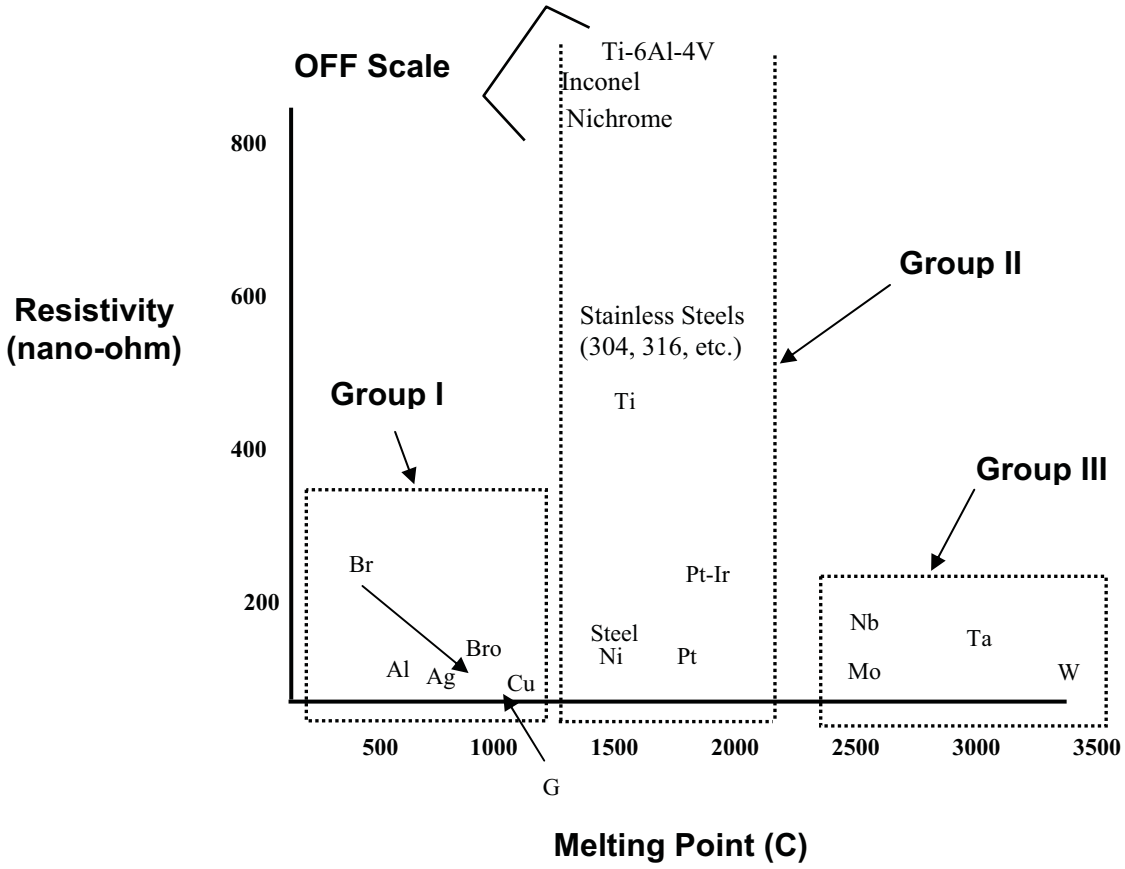
Many micro-resistance welding challenges involve joining dissimilar metals in terms of their melting points, electrical conductivity, and hardness. A solid-state joint can be an ideal solution for these difficult applications; there is no direct mixing of the two materials across the weld interface thus preventing the formation of harmful alloys that could form brittle compounds that are easily fractured. Remember that in a solid-state joint, the metals are only heated to 70-80% of their respective melting points, resulting in less thermal stress during heating and subsequent joint cooling in comparison to a fusion weld. As there is no real melting of the materials in a solid-state joint, there is less chance of weld splash or material expulsion. A weld nugget can still be achieved with a solid-state joint.

Consider the Material Properties

The important material properties to be considered in the resistance welding process are:

- ***Electrical and thermal conductivity***
- ***Plating and coating***
- ***Hardness***
- ***Melting point***
- ***Oxides***

The figure below illustrates the variance in resistivity and melting points for some of the more common materials used in micro resistance welding today.



The materials can be grouped into three common categories. The types of joints achievable within each of the main groups are detailed below:

- **Group I – Conductive Metals**

  Conductive metals dissipate heat and it can be difficult to focus heat at the interface. A solid-state joint is therefore preferred. Typically, resistive electrode materials are used to provide additional heating.

- **Group II – Resistive Metals**

  It is easier to generate and trap heat at the interface of resistive metals and therefore it is possible to form both solid state and fusion welds depending on time and temperature. Upslope can reduce contact resistances and provide heating in the bulk material resistance.

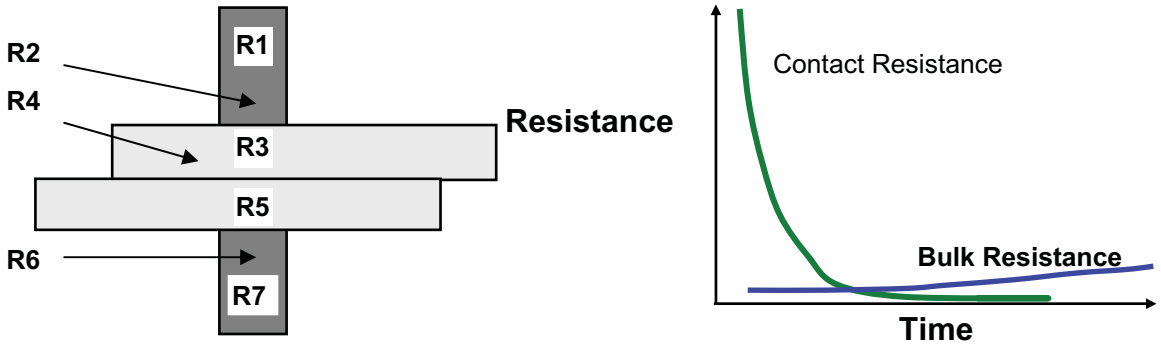
- **Group III – Refractory Metals**

  Refractory metals have very high melting points and excess heating can cause micro-structural damage. A solid-state joint is therefore preferred.

The chart below gives some guidance on the type of joint that can be expected and design considerations required when joining materials from the different groups.

	Group I	Group II	Group III
Group I (Copper)	• Solid-State • W/Mo electrodes	• Solid-State • Projection on Group I	• Solid-State • Fine projections on Group III
Group II (Steel)		• Solid-State or Fusion	• Solid-state or braze of II on III • Projection on III
Group III (Moly)			• Solid-State

Basic Principles



The figure above shows the key resistances in a typical opposed resistance weld and the relationship between contact resistances and bulk resistances over time, during a typical resistance weld:

R1 & R7 The electrode resistances affect the conduction of energy and weld heat to the parts and the rate of heat sinking from the parts at the end of the weld.

R2, R4 & R 6 The electrode-to-part and part-to-part "Contact Resistances" determine the amount of heat generation in these areas. The contact resistances decline over time as the parts achieve better fit up.

R3 & R5 The metal "Bulk Resistances" become higher during the weld as the parts are heated.

If a weld is initiated when the contact resistances are still high, the heat generated is in relation to the level and location of the contact resistances, as the materials have not had a chance to fit up correctly. It is common for the heat generated at the electrode-to-part and part-to-part resistances to cause multiple welding problems when welding resistive materials including:

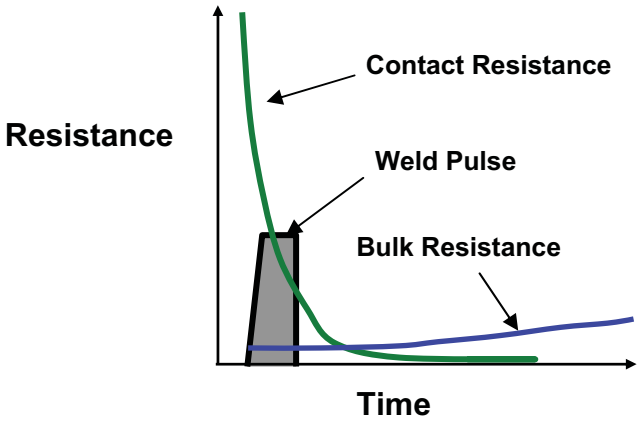
- Part marking and surface heating
- Weld splash or expulsion
- Electrode sticking
- Weak welds

Alternately, conductive materials can be welded by using high contact resistance and fast heating because their bulk resistance is not high and cannot be relied upon for heat generation.

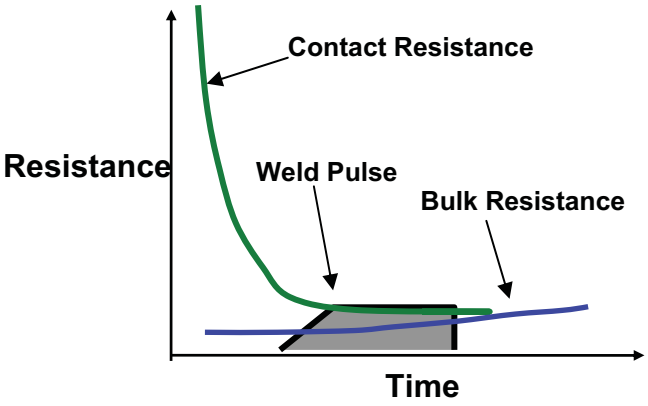
If a weld is initiated when both parts and electrodes are fitted up correctly, the contact resistance is lower and bulk resistance now controls the heat generation. This type of weld is achieved with a slower heating rate and normally longer time is preferred for welding resistive materials, which can generate heat through their bulk resistance.

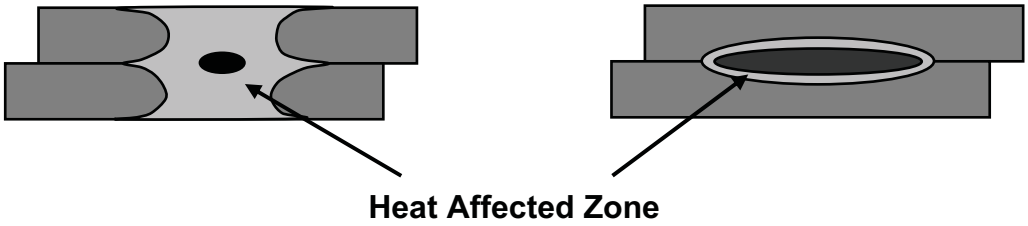
The contact resistances present at the weld when the power supply is fired have a great impact on the heat balance of a weld and, therefore, the heat affected zone.

The figure below shows a weld that is fired early on in the weld sequence when the contact resistance is still quite high.



The figure shows a weld that is initiated when the contact resistance is lower; in this example, we are using bulk resistance to generate our weld heat.

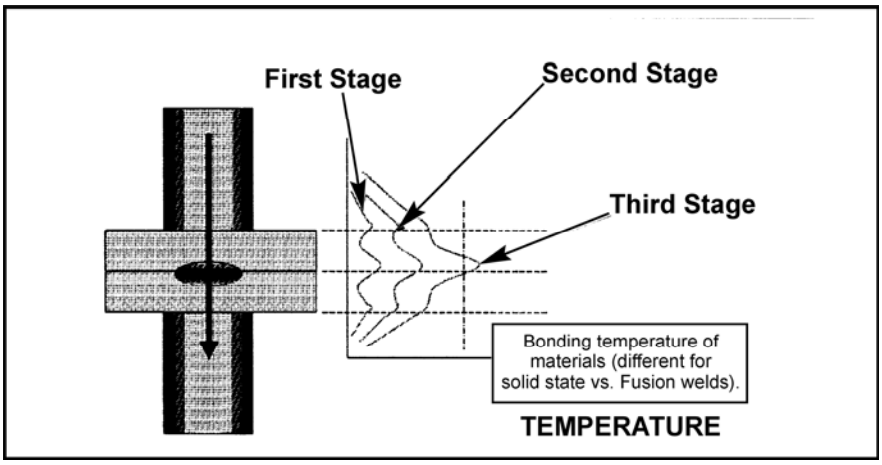




(NOTE: Larger nuggets are possible with longer weld times when using bulk resistance.)

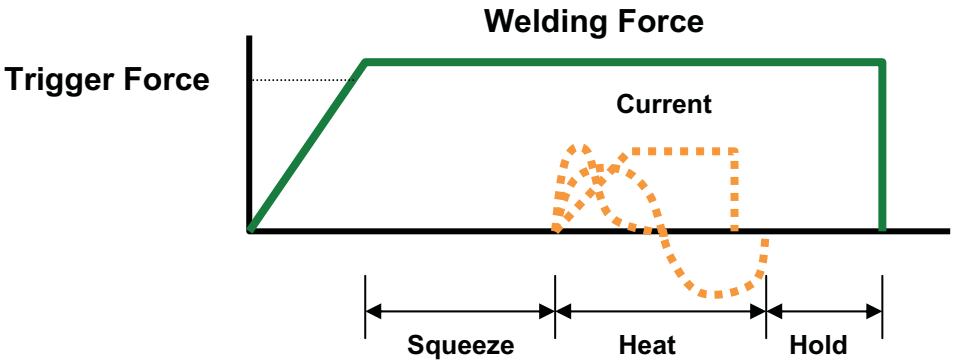
In general, conductive materials benefit from a faster heating rate, as the higher contact resistances assist heat generation in the weld. Resistive materials benefit from slower heating rates which allow the contact resistances to reduce significantly. Bulk resistances, therefore, become the major source for heat generation. The heat-affected zone is also much smaller in this case producing a weld with less variation.

The following figure shows the three stages of heat generation for resistive materials in a fusion weld. In the first stage, the heat is focused in the part-to-part and electrode-to-part contact areas, since contact resistance is high relative to bulk resistance. In the second stage, contact resistance decreases as the electrodes seat better to the parts. Less heat is generated in the electrode-to-part contact areas, and a greater amount of heat is generated in the parts as the bulk resistance increases. In the third stage, the bulk resistance becomes the dominant heat-generating factor and the parts can reach their bonding temperature at the part-to-part interface. The stages of heat generation for conductive materials will be similar to that of resistive materials, but there will be less heat generated in the bulk resistance due to the conductivity of the materials.



Weld Profiles

The basic welding profile (or schedule) consists of a controlled application of energy and force over time. Precision power supplies control the energy and time and therefore heating rate of the parts. The weld head applies force from the start to finish of the welding process.



The figure on the right shows a typical welding sequence where the force is applied to the parts; a squeeze time is initiated which allows the force to stabilize before the current is fired. Squeeze time also allows time for the contact resistances to reduce as the materials start to come into closer contact at their interface. A hold time is initiated after current flows to allow the parts to cool under pressure before the electrodes are retracted from the parts. Hold time is important as weld strength develops in this period. This basic form of weld profile is sufficient for the majority of small part resistance welding applications.

Power supply technology selection is based on the requirements of both the application and process. In general, closed loop power supply technologies are the best choice for consistent, controlled output and fast response to changes in resistance during the weld (for further details comparison see the Unitek Equipment “slide rule” tool).

Approach to Weld Development

The first stage in developing a quality welding process is to fix as many of the variables as possible in the welding equipment set up. The welding variables can be grouped in the following categories:

- **Material Variables**
  - Base material
  - Plating
  - Size
  - Shape
- **Weld Head & Mechanical Variables**
  - Force, squeeze, hold
  - Actuation method
  - Electrode material and shape
- **Power Supply Variables**
  - Energy
  - Time (squeeze, weld, hold)
- **Process Variables**
  - Tooling, level of automation
  - Repetition rate
  - Part positioning
  - Maintenance, electrode cleaning
- **Quality Requirements**
  - Pull strength
  - Visual criteria
  - Test method, other weld joint requirements

The first stage in developing a quality welding process is to fix as many of the variables as possible in the welding equipment set up. Welding variables can be grouped in the following categories:

Initial Welding Trials -- The "Look See" Tests

"Look see" welding tests are a series of mini welding experiments designed to provide a starting point for further statistical development of the welding parameters. The user should adjust the key welding variables (energy, force, time) in order to identify the likely good "weld window." Close visual inspection of the weld parts will promote better understanding of the heating characteristics of the application.

The mini-experiments should also be used to understand the weld characteristics from both application and process perspective. Key factors in this understanding are as follows:

Application Perspective

- Materials: Resistivity, melting point, thermal mass, shape, hardness, surface properties.
- Heat balance: Electrode materials, shape, Polarity, heating rate (upslope).
- Observation: visual criteria, cross section, and impact of variables on heat balance.

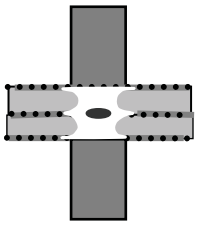
Process Perspective

- What are the likely variables in a production process?
- How will operators handle and align the parts?
- What tooling or automation will be required?
- How will operators maintain and change the electrodes?
- What other parameters will operators be able to adjust?
- What are the quality and inspection requirements?
- What are the relevant production testing methods and test equipment?
- Do we have adequate control over the quality of the materials?

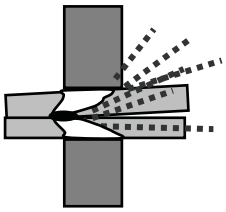
Common Problems

During this stage of process development, it is important to understand that the majority of process problems are related to either materials variation, or part-to-electrode positioning. Some examples are shown below.

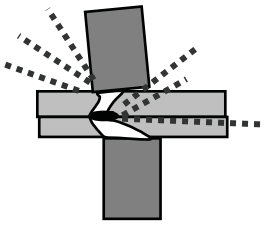
Material Control



Part-To-Part Positioning

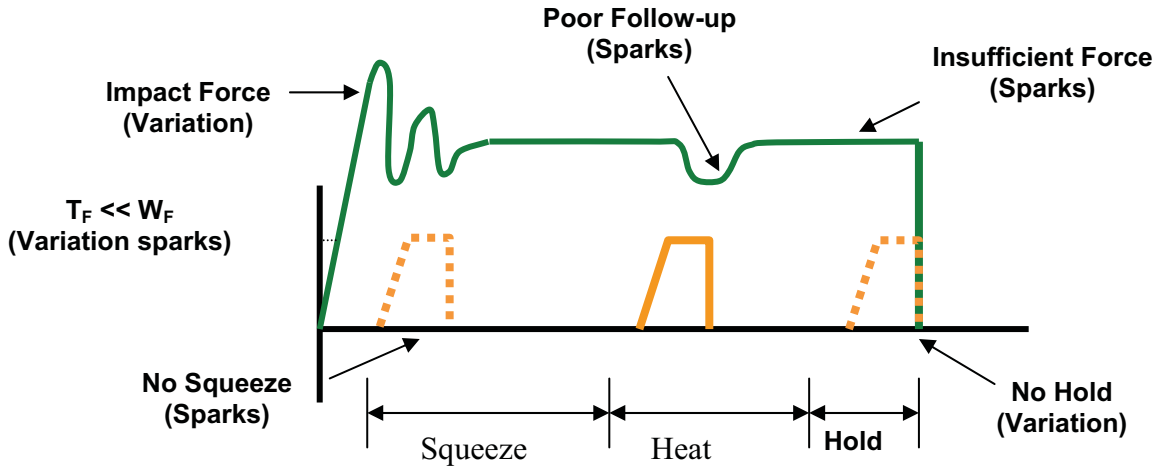


Electrode-To-Part Positioning



The changes detailed above generally result in a change in contact resistance and always affect the heat balance of the weld. During weld development these common problems must be carefully monitored so as not to mislead the course and productivity of the welding experiments.

In summary, the “look see” welding experiments should be used to fix further variables from an application and process perspective and also to establish a “weld window” for energy, time and force. This part of weld development is critical in order to proceed to a statistical method of evaluation (Design of Experiments or “DOEs”). Random explosions or unexpected variables will skew statistical data and waste valuable time.



Common welding problems can often be identified in the basic set up of the force, energy, and time welding profile shown above. These problems can lead to weld splash, inconsistency, and variation (contact Unitek Equipment for further information and support).

What are Screening DOE'S?

The purpose of a Screening DOE is to establish the impact that welding and process parameters have on the quality of the weld. Quality measurement criteria should be selected based on the requirements of the application. A Screening DOE will establish a relative quality measurement for the parameters tested and the variation in the welded result. This is important, as identifying variation in process is critical in establishing the best production settings. Typically, welded assemblies are assessed for strength of joint and variation in strength.

A Screening DOE tests the high, low settings of a parameter, and will help establish the impact of a parameter on the process. A Screening DOE is a tool that allows the user to establish the impact of a particular parameter by carrying out the minimum number of experiments to gain the information. A five-factor screening DOE can be accomplished in as few as 24 welds, with three welds completed for each of 8 tests. By comparison, it would take 96 welds to test every combination. The DOE promotes understanding of many variables in a single experiment and allows the user to interpret results, thus narrowing the variables for the next level of statistical analysis. If many variables are still not understood, multiple Screening DOE's may be required. Unitek Equipment provides a simple Screening DOE tool that is run in Excel® and is sufficient for the majority of possible applications (contact Unitek Equipment for details). Sophisticated software is also available from other vendors designed specifically for this purpose.

Criteria for Success

Before running the series of experiments, the user must establish an acceptable window for energy, time, and force, thus preventing voided results. It is common practice to include one or all of the above variables in a Screening DOE. This is only recommended if sufficient understanding has been established for the other application and process variables that can impact quality Users should first try to screen out all common application and process variables that require further exploration from the results of the "look see" mini experiments and then include the three key welding variables (energy, force and time). Several Screening DOE's may be required.

Results should be interpreted carefully. Typically, one would look for the highest result in terms of quality with the least variation. A Screening DOE provides only a measurement that indicates the relative importance of a parameter and not the ideal setting. Factorial DOE's should be used to establish the correct or best setting for a parameter once many of the other variables have been screened and fixed. This is also the time to assess the measurement accuracy and consistency of the test method and procedure. Variation in test method can invalidate the test and lead to misinterpretation of results.

What are Factorial DOE's?

The purpose of a Factorial DOE is to narrow in on the optimal setting for a particular parameter. This method is generally used when the critical or main key variables have been identified, and we need to establish the best settings for the process. A factorial DOE may also give an indication as to how wide the acceptable weld window is in relation to quality requirements. We recommend data be gathered from a monitoring perspective so that this can provide a starting point for establishing a relationship between quality and the monitored measurement parameter.

Criteria for Success

Critical parameters should be identified from the list of unfixed variables left from the Screening DOE's. A mini-experiment may be required establishing reasonable bounds for the combination of parameters to be tested. This will prevent void data and wasted time. At this stage, it is useful to record multiple relevant quality measurement or inspection criteria so that a balanced decision can be reached. For example, if part marking and pull strength are the relevant criteria, a compromise in ideal setting may be required.

As with all experiments, the test method should be carefully assessed as a potential source of variation and inconsistency. Once the optimum parameters have been established in this series of experiments, a validation study can be run which looks at the consistency of results over time. It is good practice to build in variables such as electrode changes and cleaning, as well as equipment set up by different personnel. This will ensure that the solution is one that can run in a real production environment. Welded assemblies should be tested over time and under real use conditions to ensure that all functional criteria will be met. Validation testing is usually required to prove the robustness of the process under production conditions.

Conclusion

The resistance welding process can deliver a reliable and repeatable joining solution for a wide range of metal joining applications. Defining the optimum welding process and best production settings can be achieved through a methodical and statistical approach. Time spent up front in weld development will ensure a stable welding process and provide a substantial return in quality and long term consistency. Welding problems can more easily be identified and solved if sufficient experimental work is carried out to identify the impact of common variables on the quality and variation of the welded assembly. Unitek Equipment frequently uses the Screening DOE tool to establish the impact of key variables and to assist customers with troubleshooting. Often, the testing described above will provide the information and understanding to predict common failure modes and causes. A troubleshooting guide can be requested in the form of a slide rule, to assist users in identification of welding problems and likely causes.